FEB 9 '56

The Dock & Harbour Authority

UNIVERSITY OF MICHIGAN
FEB 6 1956
TRANSPORTATION LIBRARY

No. 422. Vol. XXXVI. DECEMBER, 1955 Monthly 2s. 6d.

RAPIER Mobile Cranes FOR DOCKS

★ This RapieR 10 Super Mobile Crane with Cargo Handling Jib, at Mombasa, is estimated to have cost £10,000 less than an alternative Portal Crane

Unload any ship any time at any quay

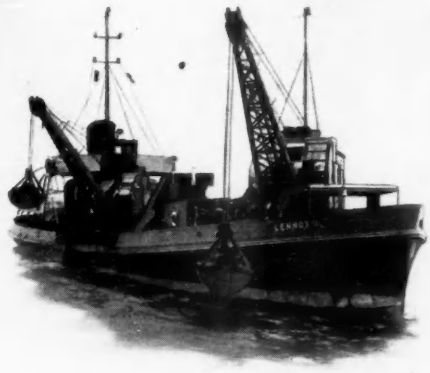
Loads 1 to 10 tons

RANSOMES & RAPIER LTD. · IPSWICH · ENGLAND

Aids to Navigation

According to legend, it was the Chinese Prince Huang-Ti who, in the year 2637 B.C. first used a form of compass. Certainly compasses had been developed to a usable form by the 13th century, at which period they were quite common.

Very little material advance in design seems to have been made subsequently, as the dry-card compass was in vogue for several centuries until the last war; which ushered in the spirit-type compass, now regarded as the ultimate in efficiency and reliability.



PRIESTMAN

In three-quarters of a century, Priestmans have brought the design and construction of Grab-Dredgers to the pitch of perfection which it has taken the compass hundreds of years to achieve. In practically every important port in the world, Priestman Dredgers may be seen faithfully, steadily and reliably carrying out the job of keeping navigational channels clear.

PRIESTMAN BROTHERS LIMITED - HOLDERNESS ENGINEERING WORKS - HULL - ENGLAND

To Correspondents

All Letters and Contributions intended for Publication should be addressed to the Editor:—K. R. Doggett, Assoc.I.C.E., "The **Dock & Harbour Authority,**" **19, Harcourt Street, London, W.1,** and must in all cases be accompanied by the name and address of the sender.

To Advertisers

Our circulation is world-wide, and we have subscribers in 83 countries. For Advertisement Rates and particulars of space available apply to the Advertisement Manager, 19, Harcourt Street, W.1.

Subscription Rates

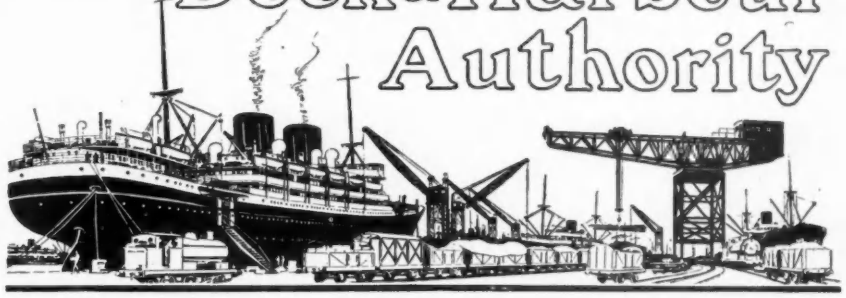
PER 2/6 COPY
(plus 4d. postage).

Annual Subscription:—
United Kingdom ... £1 10s. 0d.
Abroad ... ... £1 12s. 6d.
(post free anywhere).

All subscriptions must be Prepaid. Postal Orders and Cheques should be addressed and made payable to FOXLOW PUBLICATIONS LTD., 19, Harcourt Street, London, W.1, and crossed Midland Bank, Ltd.

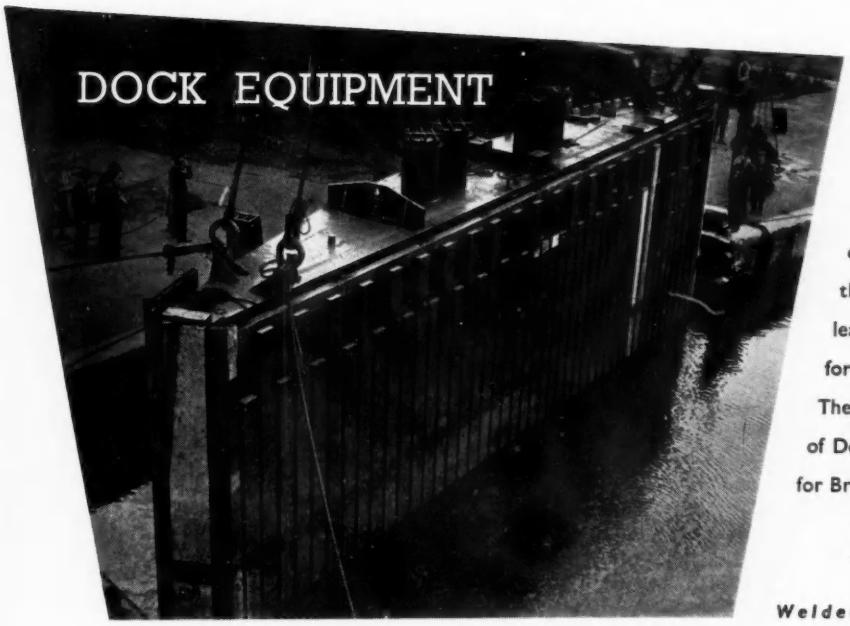
Telephone: PAD 0077 and 0078.

The Dock & Harbour Authority



CONTENTS

EDITORIAL COMMENTS	235
THE PORT OF GEELONG, VICTORIA	237
NAVIGATIONAL AID FOR SMALL HARBOURS	242
DOCK LABOUR IN NEW ZEALAND	243
THE HOPPER DREDGE	245
PNEUMATIC AND SIMILAR BREAKWATERS	251
THE WORKING OF THE LONDON DOCKS	256
THE RAPID TURN ROUND OF SHIPS	258
RECENT METALLURGICAL PROGRESS	261
SUBMARINE TELEPHONE CABLE LOADING	263
NEW GANTRY CRANES AT LONG BEACH	264
THE STABILISATION OF A TIDAL LAGOON	264
CORRESPONDENCE	265
BOOK REVIEWS	266
MANUFACTURERS' ANNOUNCEMENTS	267



The illustration shows the stepping into position of one leaf of a pair of 100' Entrance Gates for the Port of London Authority. Each welded leaf weighs 240 tons, compared with 350 tons for each riveted leaf which it is replacing . . . These gates are illustrative of eight pairs of Dock Gates at present under construction for Britain's Docks, Harbours and Waterways.

DOCK GATES *CAISSONS*
FLOATING DOCKS *SLIPWAYS*
MOVABLE BRIDGES
Welded or Riveted Construction

HEAD, WRIGHTSON & Co LTD
THORNABY-ON-TEES • STOCKTON-ON-TEES • MIDDLESBROUGH • LONDON
JOHANNESBURG • TORONTO • SYDNEY, N.S.W.

296—Rd

Ready for anything

. . . up to 12 tons

Standard jib 60 ft. long in four 15 ft. sections for convenient handling. Crane unit powered by a Perkins L4 diesel engine fitted with a fluid flywheel and controlled from the driver's cabin, the driver being separately enclosed with all necessary controls in his cab eliminating noise. All parts easily accessible for maintenance and adjustment, and lubrication to all principal grease points is piped through "Trabon" valve to a hand pump and reservoir.

'STAFFA 12'

12-ton capacity lorry-mounted crane is mounted on a specially constructed chassis fitted with an A.E.C. 9.6-litre diesel engine. Hydraulically - operated providing finger-tip control. Full details and specification on request.

CHAMBERLAIN INDUSTRIES LTD

STAFFA WORKS, STAFFA ROAD, LEYTON, LONDON, E.10

The Dock & Harbour Authority

An International Journal with a circulation extending to 83 Maritime Countries

No. 422

Vol. XXXVI.

DECEMBER, 1955

Monthly 2s. 6d.

Editorial Comments

The Port of Geelong.

Geelong was proclaimed a settlement 118 years ago, at a time when the area now known as the State of Victoria was a far flung and almost unsettled appendage of the Colony of New South Wales. In common with other Australian settlements, the primary interest of the pioneers was in the possibilities of sheep farming in the area. Similarly did the neighbouring port of Melbourne find its beginnings, and although nowadays Geelong is the second city of the State of Victoria, its expansion was in the beginning hampered by obstructions to navigation, since removed. It was partly these obstructions which enabled Melbourne in the 19th century to gain the lead as the principal port of the State, despite its less favourable situation.

Both ports passed through the hectic era of the gold rush of the early 1850's, since when there has been a gradual divergence of purpose, Melbourne becoming a leading port for wool exports and general cargoes, while Geelong has developed rapidly in recent years as a manufacturing port, in which imports and exports are predominantly bulk cargoes.

At the time when the Geelong Harbour Trust Commissioners were empowered by legislation in 1906 to administer and improve the affairs of the port, Geelong's trade was primarily in exports. Since State policy both then and now was to free exports from wharfage rates, the Commissioners found themselves rendering services for which there was not a corresponding revenue. It is interesting to see, in our leading article on another page, how the balance of imports and exports has been rectified by vigorous development in the port of industrial areas, whose demand for bulk raw materials has resulted by the year 1954 in a satisfactory surplus of import tonnage.

Report on London Dock Working.

Extracts from the report recently published by the London Chamber of Commerce on the above mentioned subject appear elsewhere in this issue. The report is concerned with steps which might be taken to reduce delays to goods passing through the Port of London and states that the causes of such delays fall under two headings, viz. operational problems and labour difficulties.

Steps which are advocated under the first heading would, if taken, do something to alleviate the present situation. It is a fact that, all too frequently, more than half a ship's ex-quay export cargo is tendered to the berth at the end of the receiving period, placing the dock authorities in an impossible position and being the direct cause of congestion, delays and lost journeys. The report therefore rightly emphasises the need for special steps to be taken to ensure an even flow of traffic, it points out that the loading of a ship is not governed by the order in which the goods arrive at the berth and it makes the suggestion that congestion would be reduced if traders generally were to receive and deliver goods on Saturday mornings.

As far as the other section of the report is concerned, there is no doubt that if labour were more amenable, many of the difficulties at present experienced at the docks would disappear. The Chamber's opinion is that the main reason why the men will not co-operate with new goods handling methods is that at the back of their minds there is the fear of unemployment and a return to the casual labour evils which existed before the war. There is another important factor, however, the full strength of which it is difficult to assess. The conditions of employment to-day under the National Dock Labour Scheme, permit any man who feels like wielding power, whether for reasons of vanity, personal gain or politics, to wield it. Such men are the bane of the conscientious Union official and whether they incite others to go slow, to strike, to introduce a restrictive practice or to refuse to use the conciliation machinery of the industry, the employers to whom they are temporarily attached are powerless to deal with them. When this is understood, it can be seen that the serious labour difficulties with which the London Chamber of Commerce has been concerned, are in the main, only another symptom of the ailment from which the port industry in this country is suffering, due to certain inadequate arrangements imposed on it through the operation of the National Dock Labour Scheme.

Hopes of a solution to this part of the problem must therefore revolve about the achievements of the committee set up by the Minister of Labour to enquire into the working of the National Dock Labour scheme. This committee has a most difficult and complicated task which it is hoped can be accomplished successfully, for the matter involved is one of vital importance to British industrial prosperity.

Rapid Turn-Round of Ships.

The strictures of the London Chamber of Commerce on the practice of late delivery of export cargo, mentioned above, acquire added force in another connection, namely in so far as such practices have an adverse effect on the planning of loading operations to the best advantage. An article on another page deals with the effects of loading operations on the speed and cost of discharge. It is shown that loading and stowage of export cargoes must be planned with a view not only to the proper distribution of packages according to classification, centre of gravity and ease of handling into the hold, but also with the realisation that the same cargo has to be discharged again in ports of varying efficiency.

It may be argued that problems of stowage and discharge are no concern of the shipper, and that it is up to the stevedore and shipowner to make his own dispositions as best he can. But it would seem that in the interest of seaborne trade as a whole, on which the exporter depends for prompt delivery of his goods, it would be no bad thing if exporters and shippers were to make themselves acquainted with the nature of the problem of stowage, and of the dislocation which can be caused by tardy delivery of bulky goods. Thereby they would acquire some sympathy for a complex process and thus help to bring some slight amelioration to quayside bottlenecks.

Pneumatic and Other Breakwaters.

In the June 1955 issue of this Journal we printed a condensed version of German experiments on pneumatic breakwaters, together with a review of the results obtained. On another page of this issue will be found the results of model tests carried out by the British Transport Commission, Docks and Inland Waterways. Both the German and the British experiments were engendered by the performance of the only full scale pneumatic breakwater to be

Editorial Comments—continued

built in recent years, at Dover, an account of which appeared in the December 1952 issue of this Journal. Whereas the German conclusion was that pneumatic breakwaters represented the most economic solution in all cases where fixed installations must be ruled out, the British conclusion is less optimistic, and it is stated that the complete calming of waves of 200-ft. or more in length is unlikely to be economic and may be impracticable.

While the approach and interpretation of results are in each case quite different, it may be said that the British viewpoint confirms a belief of long standing that any attempt to secure protection from waves by projecting contrary currents calls for unacceptable expenditure of power. Insofar as this viewpoint is now re-inforced, the Docks and Inland Waterways research will have served a useful purpose in disposing of that method as a matter of practical engineering. But it should be noted that there are other interpretations, and other methods to which reference has been made in recent issues of this Journal, by which waves may be artificially reduced, and it does appear that the subject is by no means closed. Further investigations are, it is understood, now proceeding.

Second International Port and Harbour Conference.

At the Second International Port and Harbour Conference, held in Los Angeles last month, it was decided by delegates representing fourteen countries to form a permanent International Association of Ports and Harbours. The declared purposes of this Association are to promote an exchange of information on the techniques of port management, operation, development and promotion, to stimulate waterborne commerce throughout the world, and to encourage the standardisation of import, export and vessel clearance procedures. Following formation of the Association, a constitution and by-laws were adopted and port officials from the fourteen countries signed cards signifying the intention of their respective ports to become members. Mr. B. J. Roberts, Chairman of the National Harbours Board of Canada, was elected president of the new Association; Mr. John-Iwar Dahlin, director of the Port of Halsingborg, Sweden, was elected first vice-president; and C. M. Chen, adviser in the Ministry of Communications, Republic of China, second vice-president. The Board of Directors will consist of one member from each country represented in the Association. The Central Secretariat is to be located in Japan.

Attending the meeting were 140 port and government officials from Brazil, Canada, China, Germany, India, Japan, Korea, Liberia, Mexico, Peru, Sweden, Thailand, Union of South Africa, Venezuela, Vietnam and the United States. It is conspicuous that only two European countries, Sweden and Germany are represented in the above list and that the "centre of gravity" of the organisation seems to lie in the Far East and the New World.

It is to be hoped that the membership of this new Association will in due course become more representative of the principal maritime countries of the world. Without such membership its declared objects can hardly be fulfilled to the best advantage.

British Inland Waterways.

The future of the British canal system, which has often been reviewed in this Journal, is once more a topic engaging public attention. This subject is of more than local interest, since the problems involved have much in common with those encountered in other engineering fields. The most important of these concern possible modernisation of certain portions of the system, on the one hand, and the disposal of those waterways which no longer fulfil the functions for which they were originally designed on the other hand. When the situation is seriously investigated, as it has been, for example, by the 1906-11 Royal Commission and by the recent Board of Survey, the conclusions, difficulties and recommendations follow a familiar trend. The pattern of trade changes; labour costs increase; new techniques are developed; the condition of some works deteriorates. Inevitably one is faced with the need for a decision upon what can be retained, and planned for modernisation and what must be regarded as having insufficient inherent worth to justify further expenditure. When one has to deal, in the latter category, with such works as are comprised in some 800 miles of waterway, which authoritative opinion has classified as incapable of further economic exploitation, one hesitates before condemning some of the finest examples of eighteenth century engineering to abandonment. For this and other reasons, the recent Board of Survey has advised that these waterways, which are specified, should be transferred from the Transport Commission to River Boards or similar bodies in order that they may be kept in existence for amenity, pleasure boats, angling, drainage, water supply and other purposes unconnected with commercial transport.

It is not, therefore, surprising that this subject arouses controversy. Most of those engaged in commercial transport on the routes at present active continue to advocate concentration of the Commission's resources on these routes, instead of their dissipating them on canals which have no future; they are not satisfied that modernisation of these active routes is progressing fast enough. Broadly these are routes which connect with ports, so that the canal boats can act as lighters in dock areas and relieve congestion there, and which accommodate boats of at least 100 tons capacity. Their interest in existing business tends to distract attention from the possibility of schemes for modernisation to the same standard of other selected sections, and to create an impression that no more than 300 miles can be run economically. The argument from the other side is that no waterway should be allowed to deteriorate further, and that canals which now carry very little traffic could be made successful at very moderate expense. Since the protagonists of this cause cannot accept the recommendations of the Board of Survey, they demand still another enquiry. Although this denfensive move may be well-intentioned, the effect is likely to be deplorable, since it will only extend the period of uncertainty and unrest which has haunted this industry with varying degrees of intensity since the end of the war.

The Kennet and Avon Navigation.

Much of the current controversy about British Canals centres round the Kennet and Avon Canal, which connects Reading on the Thames with the Avon and Bristol. This canal is typical of those which have been virtually disused for 50 years and more. In a recent action by a bye-trader endeavouring to trade on the canal, the Commission admitted that the navigation was not in navigable condition and offered substantial compensation. One object of the action was to prevent further deterioration and bring about some rehabilitation. The effect may well be the reverse, since the Commission, unable to tolerate a series of such actions, has sponsored a Bill which seeks to extinguish rights of navigation and to authorise a scheme to transfer the waterway to some other body. In opposition to this Bill figures have been quoted which purport to show that there is enough traffic on offer to justify restoration. We believe it important to distinguish between mere restoration to the original standard of the navigation, that is to pass 60-ton horse drawn barges, and modernisation so that powered vessels of economic size could operate at a reasonable speed. The former might cost less than one million pounds, but this, we fear, would be so much money wasted since the transport costs are likely to be too high to compete with rail, road and coastal shipping. Courageous modernisation at least to the River Trent standard might enable competitive transport rates to be quoted. Whether the capital expenditure approaching ten million pounds can be justified on this route is another matter, whilst water supply near the summit level and elsewhere would involve considerable engineering difficulties. If any existing canals at present only capable of passing 50-ton boats or less are to be modernised, there are some for which there is a better case than the Kennet and Avon. The opponents to this part of the British Transport Commission's Bill must show whether the extensive traffic on offer can be guaranteed for a period of years at tolls sufficient to justify the expenditure for restoration or modernisation.

New Floating Dock for Hamburg Yard.

A floating dock capable of receiving vessels of up to 3,500 tons displacement has been purchased by the Deutsche Werft, Hamburg, at a cost of 1,800,000 DM. The dock formerly belonged to the German Navy, was seized by the Allies at the end of the war and has subsequently been in service at the yard of the Flensburger Schiffsbau A.G.

The Port of Geelong, Victoria

A Progressive Australian Industrial Port

By R. R. PHILLIPS
(Secretary to the Geelong Harbour Trust Commissioners)

GEELONG, with a population of approximately 80,000—nearly doubled in the past fifteen years—is the second city in the State of Victoria. Estimates place the population, within about 10 years, at well over 100,000.

The Port of Geelong—the area controlled by the Geelong Harbour Trust Commissioners—covers in all 90 square miles and includes the bed and shores of Corio Bay, the western area of Port Phillip Bay. In addition, the Trust has vested in it, or owns in its own right, various landward areas along the foreshore and elsewhere. These lands, as will be seen later, have been of inestimable value to the Port and Geelong generally, in their having been available for waterfront and other industrial undertakings. Geelong is 45 miles distant, by rail or road, from the capital city of Victoria, Melbourne. A large area of the harbour has a natural depth of more than 32 feet of water—mainly so in the outer portion of the harbour: little of the inner harbour extends beyond a natural depth of 30 feet, but this depth in parts is available very close to the shores.

Short Historical Outline

Before presenting a detailed description of the Port and its present and projected facilities, it is perhaps appropriate at this stage to give a brief survey of its history.

Geelong was proclaimed a settlement in October 1838—by the then Governor of New South Wales, of which colony the area now known as the State of Victoria was a far flung and almost unsettled appendage. However, the history of Geelong, and of its port, began some few years earlier, when John Batman, a sheep farmer from Tasmania (then known as Van Diemens Land) landed in 1835 near the eastern extremity of Corio Bay. He explored the surrounding countryside and found that discouraging reports by earlier explorers were unfounded: he was amazed at the possibilities which existed for his purposes. The incentive for his venture was the successful establishment of a farming project at Portland by the Henty brothers, also from Van Diemen's Land earlier in the same year. Batman bought from the local aborigines 100,000 acres for the conventional consideration of axes, blankets, flour and the like. Most formidable documents were prepared and sealed by the high contracting parties, but the Government situated in Sydney refused to acknowledge their legality. Incidentally a somewhat similar "purchase" was also made from the natives of the area where Melbourne now stands. Batman's party was naturally astonished to find living with one of the tribes a white man. He was an escaped convict, one William Buckley who had been accepted some thirty years previously as the reincarnation of a famous chief and had lived a tribal life during all that period. Later, he was removed from his associates, pardoned and employed—not very successfully—as a minor Government official and interpreter.

Reports of the fertility of the surrounding country quickly drew others to investigate. These, in increasing numbers, came with their flocks of sheep and stayed; so that by the end of that year, most of the land within a range of about 75 miles was occupied. With this movement, the small village of Geelong arose—partly along the seaboard and, for the sake of fresh water, partly along the left bank of the Barwon River which flows close by, though its nearby mouth is not on Corio Bay.

These settlers arrived in small vessels almost entirely from Van Diemen's Land and disembarked on a projection to the eastward, and now called Point Henry. The reason for selection for this position was the fact that from the point a shallow bank extended north yard and more or less right across the bay.

An Embryo Port

Together with the use of a jetty at the village for small craft, this state of affairs appeared to prove reasonably satisfactory until the accession of overseas shipping associated with the gold rush of the early 1850's when Geelong, rapidly growing, was one of the two focal points for the arrival of immigrants seeking fabulous fortunes (for some) at Ballarat and other gold-producing areas. During this period, repeated but unsuccessful endeavours were made to pursuade the authorities (by then the Victorian Government) to provide a channel through the spit. It was not until 1854 that a partly natural channel was found on the northern shore of the bay, and was dredged to a minimum depth of 13 feet at low water, enabling small craft to enter at any stage of the tide but by a very roundabout course.

The encountering of rock put out of the question any improvement to this channel, and in 1862 another cut, somewhat to the southward, was made. This provided 18 feet of water, but owing to its extreme narrowness it was not regarded as an unqualified success.

In the meantime, the Port of Melbourne, despite its natural disadvantages, forged ahead as the main port for Victoria. Geelong, with ample depths available almost to the water's edge, was for the lack of a suitable entrance forced to take second place.

Pressure of local opinion, however, eventually provided the necessary impetus to the State Government to attack this very serious state of affairs in a proper way; and at last, in 1893, portion of what is still termed "Hopetoun Channel" was completed for a length of about two miles, providing then at low water a minimum depth of 23 feet and a navigable width of 132 feet.

A matter of particular interest to the Port of Geelong is its virtual freedom from maintenance dredging. With a minor tidal range (two to three feet), absence of other water movement except surface waves, and with no streams of any consequence debouching into the harbour, siltation (except for a very little at the berths) is avoided. Moreover, the dredging is mainly of firm clay.

With the provision of Hopetoun Channel, the Port of Geelong was then equipped to secure, although too late by 50 years, that small remnant of general trade which otherwise had so effectively been diverted to Melbourne, an almost wholly artificial port. But for this delay, the natural superiority of the Geelong hinterland over that of Melbourne and the approximately 5,000 acres of sheltered anchorage and berthage in the Inner Harbour, in comparison with the continually shoaling Yarra River and other portions of the Port of Melbourne, would probably have changed the political geography of Victoria.

In the meantime, many world famous sailing ships were frequent visitors to Geelong—for example "Lightning" which, unfortunately, found here its last resting place after being afire on 31st October 1869. Nearly 70 years later, dredging operations in the vicinity recovered from the mud bottom quantities of her timbers and small portions of wool—both in a remarkably sound state of preservation.

With the gradual replacement of the sailing vessels by steam and the consequent increase in tonnage of the ships visiting the port—occasioned to some extent by the facilities then offered, once again the periodic agitation commenced for a deeper and wider channel. It must be borne in mind that during all these years Corio Bay was under the direct control of the State Government, and the only means of voicing public demand was through the maritime committees respectively of the Town Council of Geelong and the Geelong Chamber of Commerce and Manufactures. These were both admirable bodies but not specially fitted for the onerous task

Port of Geelong, Victoria—continued

of superintending the affairs of the harbour. It is of interest to recall at this stage that even the Melbourne Harbour Trust was not constituted until 1876.

The Geelong Harbour Trust

Such a body was urgently required at Geelong, and ultimately a Bill became law, on 12th December 1906, whereby the newly-appointed Geelong Harbour Trust Commissioners were empowered among other things, to improve and maintain the "bed, soil and shore" of the bay extending to a line drawn from the township of Portarlington northerly to Little River. The total area of water was about 90 square miles. The present Board consists of Messrs. J. Spencer Nall, C.M.G. (Chairman), H. A. Lumb, J.P. (Deputy Chairman) and E. J. Fairnie, C.B.E., J.P. The two former have been in office since 1933 and the latter since 1937.

The purpose of the appointments and the intention of the Government were undoubtedly good, but what was evidently overlooked were the means of securing adequate finance for the many works to be undertaken.

Except for the large trade in black coal from New South Wales, Geelong was almost wholly an export trade. As the State policy was, and still is, to free export goods from wharfage rates, the Commissioners found themselves supplying facilities for which to the major extent no revenue was forthcoming. Nevertheless a struggle was made to provide greater dimensions in the one existing channel, and in the years from the inception of the Trust to 1933 there was gradually reached a minimum depth of 29 feet at low water, a navigable width of 220 feet, and a length of over 2 miles. With incidental dredging, a general minimum depth throughout the port of 26 feet at low water was provided. This ultimately secured a draft for vessels of 25-ft. This new draft sufficed for some years the needs of shipping, which had, of course, grown with the times. However, there were many other improvements necessary to equip the port effectively—berthage was largely old and out of date, and cargo accommodation was virtually non-existent.

Despite the establishment between 1923 and 1928 of three large industries of maritime interest, Ford Motor Company's headquarters in Australia, and two superphosphate plants (making Geelong the premier port in Australia for imports of the main components — phosphatic rock and sulphur) the accumulated financial burden on the Trust was overwhelming: Lascelles Wharf and Corio Quay North No. 1 had been constructed by the Trust to serve these new industries.

Following the appointment of new Commissioners in 1933, on a report with recommendations submitted by them through the incoming Chairman, the Government of the day passed an Act which gave relief from past troubles and some hope for the future.

The Port Commences to Expand

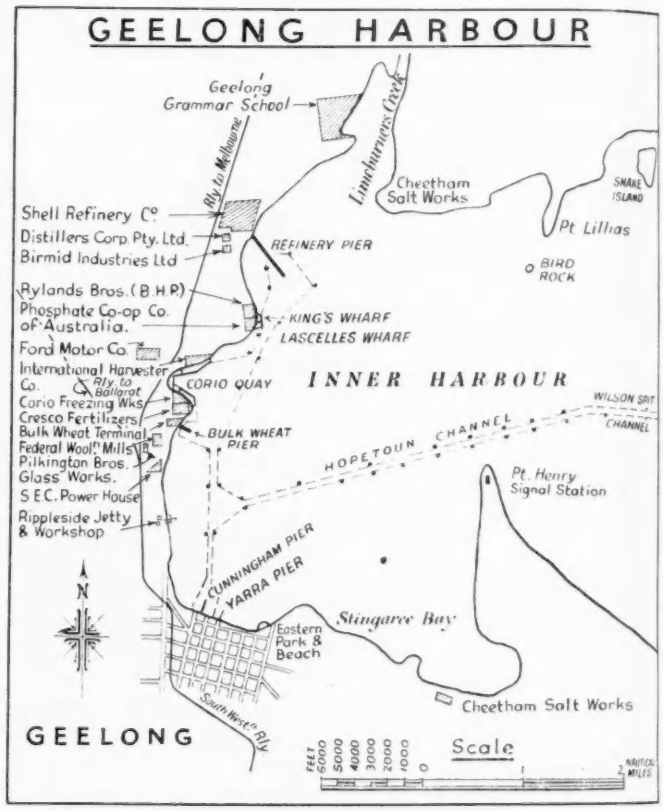
The immediate principal aim of the new Commissioners was the provision of a new and straightened course through instead of around Wilsons Spit, a general minimum depth of 29-ft. at low water to all principal berths, and a navigable width of 300 feet. This work, including the provision of light beacons, was commenced in 1934 and completed in 1938, the new section being called Wilsons Spit Channel. Notwithstanding the depression period, it was effected wholly out of revenue.

During this period the Bulk Wheat Terminal (now much enlarged and reputed to have the greatest single accommodation for wheat in the world) to serve the whole of Victoria's wheat export, was constructed together with its associated pier. This pier and installation, still the cynosure of overseas managements because of their special features, was provided by the State Authority concerned—the Grain Elevators Board; but by mutual arrangement, the Trust handles the shipping movements and collects normal revenue from the ships—there are no charges on the exported grain itself. This is the only pier not immediately owned and controlled by the Trust.

Shortly after the opening of the widened and deepened approaches, and immediately prior to the 1939-45 war period, the industrial growth of Geelong was further advanced by its selection as the main manufacturing centre for Australia of International Harvester Co. A similar decision was made by Pilkington Glass (Aust) Ltd. To cater, in particular, for seaborne trade of International Harvester Co., Corio Quay North No. 2 Berth was built continuous with but a slight angle to North No. 1 which was built earlier and primarily for use by Ford Co. In the meantime, the former berth has been used mainly for cargoes other than for International Harvester Co.

The War Intervenes

With the outbreak of war in 1939, there was little attraction for the establishment of new industries using seaborne traffic, but existing industries such as Fords and International expanded considerably. During this period, because of the unavailability of manpower and plant, little work of an improvement nature was attempted by the Trust, which, however, was able to accumulate some



funds against the time for resumption. But this resumption was further delayed after the war: capable engineering officers were practically unprocurable, while the ban on use of certain materials was very strictly policed by the Commonwealth Government.

Major Works Commence

By 1950, many of the difficulties of the post-war period were beginning to cease. The Commissioners were then able to put into real motion an overall port development project which in the meantime had been planned, to a considerable extent, in detail. About the same time, industrial activity recommenced, with the result that several new major undertakings were established in Geelong. Of these, the principal (as far as the port was concerned) was the Shell Company's refinery on the northern reaches of the Inner Harbour covering an area of 260 acres. In addition, existing factories extended their scenes of operation to a very considerable degree.

It is pertinent to mention here that most of the industries established in Geelong since 1923 have purchased or leased their lands from the Trust or have been assisted, in one way or another, in securing sites. The Commissioners have from time to time purchased available areas on and adjacent to the foreshore—this in addition to the lands vested in them under their Act. It is now

Port of Geelong, Victoria—continued

almost a standard practice for site enquiries to be made first to the Trust.

The first major post-war work was the construction of Kings Wharf—in continuation northward from Lascelles Wharf which was simultaneously lengthened by 100 feet to accommodate the larger phosphate vessels using the port. Kings Wharf is 560-ft. in length, 50-ft. wide, and with flush reinforced concrete deck at 12 R.L., the future standard of all berths as they are constructed or reconstructed. This wharf is primarily for importation of steel and allied cargoes the trade in which is rapidly growing. It was completed in 1953.

The next berthage construction was that of Refinery Pier to serve the the Shell Refinery. This pier consists of a long approach, partly earth embankment and partly timber jetty with precast concrete slab decking, and with berthing head to accommodate two tankers each of 28,000 deadweight tonnage. In the meantime, pending the ability of these larger vessels to enter the port, the Shell Company is using 18,000 deadweight ton tankers. A special feature is the provision of mooring dolphins constructed of Peine steel piling (2 lengths welded to make piles up to 88-ft.) which are able to take a berthing blow of 180 tons (Fig. 5). This pier was completed in June 1954; and it is proposed to provide additional equal berthage by way of a branch jetty and pier head to the south.

View southward from Corio Quay, showing in background, portion of city area and city piers; in middle ground, bulk wheat terminal, one of the two superphosphate works, freezing works. Corio Quay South Berths Nos. 1 and 2; in foreground, reclaimed area and reclamation walls, North Berths Nos. 1 and 2, portion of International Harvester Works and (at bottom right) a corner of Ford Motor Works area.

Other Additional Berthage

In anticipation of the use of sand filling for reclamation of about 23 acres at Corio Quay North and West, construction of steel sheet piling retaining walls was carried out behind Nos. 2 and 2 North Berths each of 560-ft., and further westward along the rear line of proposed extension of berthing—about 1,900 lineal feet in all. At the same time, across the western end of Corio Quay, an earth retaining wall was constructed, with a view to later berthage extensions. The steel sheet piling anchor walls and tie rods were placed in position after the sand filling had been deposited. A suitable depression was temporary left for the prosecution of the anchor walling, and grading was then effected (see also reference to "Deepening the Waterways," later).

The area so reclaimed will be the basis of rail and road connections to, and cargo sheds behind, the adjacent present and future berths. Work on each of these features has been commenced, the first of the cargo sheds, 320-ft. by 90-ft. being expected to be completed by about October, 1955.

Plans for the reconstruction of No. 1 North and one additional berth, in continuation westward, have been completed ready for tenders. These two berths will be at the new standard height, 12 R.L., and each will have rail tracks but with flush concrete decks for use also by road vehicles. The latter of 600-ft. will be primarily provided for coal and allied trades, with mechanical unloading gear, and when competed will relieve the central city area of the incongruous coal discharge which for so long has been effected at Cunningham Pier. The construction of this berth will be such that it will be equally useful for general cargo.

In the not so distant future a further berth (across the western, or inner end of Corio Quay) will be constructed. This too will be able to be provided by direct rail and road access.

Deepening the Waterways

Coincidentally with the above major works, the Trust had commenced, with its own (but out of date) dredging plant on the programme of deepening the approaches and all berthages from the then prevailing 29-ft. to 32-ft. at low water, to provide a draft of 30-ft. The requirements of the Refinery were such, however, that a speeding up of the work was imperative. The services of Australian Dredging and General Works Pty. Ltd., a subsidiary of overseas contracting companies, were secured, and, with a minor exception and one of no urgency, the work has now been finished. The first vessel to enter on the increased draft berthed in September, 1954. The cost of this dredging was over £1,500,000, being part of the overall expenditure of about £5,000,000 expected to be reached within about two years from 1955.

Prior to the commencement of the major portion of this contract, the Trust arranged with the Contractors for the dredging (from a selected area in the Port but away from the channels) of about a half million cubic yards of fine sand for reclamation purposes at Corio Quay. This was secured by bucket dredging, dumped in a pre-dredged area nearby, and thence pumped by suction dredge behind the reclaiming walls, of which mention has been made earlier.

As also stated, maintenance dredging in the port, except to a minor degree at lengthy intervals at the berths, has been non-existent. It is possible that some maintenance may be encountered in the future; but, if any, this should be very limited indeed.

With the increased depth, the lengthening of the former channels was of course necessary, and in addition, as will be noted from the locality plan, two new short channels have been developed: that northward along the western shore, Corio Channel, extending to Refinery Pier; and that southward, City Channel, extending to the city area piers.

Port of Geelong, Victoria—continued

Shell Refinery at Corio, and Refinery Pier. Catalytic treatment plant (near foot of pier) is now in use. Branch jetty and berthing head will duplicate berthage.

The former navigable width of 300-ft., except for necessary turning points, has been retained. This decision was reached because of the insistence by pilots of one-way traffic in channels and this insistence would probably have been maintained on any reasonably economical widening.

For the same reason, it was necessary to provide further navigational lighting in the channels. Lighted beacons were increased from 21 to 50 in number, including additional ones between those formerly in place. Prior to this period, all lights were operated by A.G.A. compressed acetylene installations. The additional ones are all electric battery installations—the first of that kind in Australia, except for isolated units. All the gas lamps have now been concentrated on the port side of Point Richards, Wilsons Spit and Hopetoun Channels, and on the starboard side of these and throughout the other channels, the new electric lamps are operating. Opinions sought from masters have elicited statements to the effect that these are the best lit open waterways in Australia.

Control of Shipping Movements

Pilotage is compulsory. It is controlled, not by the Trust, but a State Authority, the Marine Board of Victoria, and operates from the ocean entrance to Port Phillip Bay to and from both the Port of Melbourne and the Port of Geelong. There are some exemptions from pilotage, but these are granted only to certain masters plying interstate.

Port movements of vessels are controlled by the Trust's modern signal station at Point Henry, opposite Hopetoun Channel and under the direct supervision of the Harbourmaster. Here are to be found every necessary adjunct to successful control, including the continuous attendance of experienced signalmen who have never yet been caught napping either actually or metaphorically. Vessels approaching the east end of Wilsons Spit Channel are given the signal "Stop" or "Go" for entry; and masters ready to leave the inner harbour, outbound, are acquainted with the position by telephone connection to the vessels at the berths. From any one of the five anchorages, visual signals are exchanged as necessary. In addition, general information is conveyed to and received from vessels while entering or leaving. As usual, inward vessels have first right of way. Notwithstanding this one way traffic, very seldom is any material delay experienecd by vessels.

The Trust, with its own tugs, operates all commercial towage; also mooring lines services by launch. Tugs (all diesel) now available are "Spencer Nall," 1,310 b.h.p.; "H. A. Lumb," 700 b.h.p.; and "Edwd. J. Fairnie," 400 h.p., plus a smaller tug for minor work. The first named tug has recently been delivered from United Kingdom, where its counterpart "Geelong" is in the last stages of construction. The need for two of this powerful class of tug arose particularly for the handling of tankers of 18,000 deadweight tons, and, probably later, of 28,000 deadweight tons.

Trade of the Port

Both imports and exports are predominantly bulk cargoes. Furthermore, the major portion of general cargo, not including such items as steel, pig iron etc., is destined for such works as Fords, Shell Refinery and the like: hence the past omission in the provision of transit sheds. With the rapidly growing local population, an increase in the direct importation of consumer goods (now mostly imported through the mercantile houses of Melbourne) is expected; and, in fact, some improvement in this position has already been experienced. Moreover, endeavours are constantly being made to induce wool buyers and agents to use Geelong as the direct export port for a substantial portion of the 350,000 bales sold annually through the local wool exchange. The recent commencement of provision of transit sheds arises partly also from the need to accumulate a reasonable number of bales prior to the arrival of a vessel.

Until 1923, with the exception of coal from New South Wales and timber from overseas, the imports were negligible. The port depended otherwise on charges against vessels, as no wharfage rates have ever been imposed on exports, bagged wheat being then the principal feature of this trade.

With the accession of industries from about that time, particularly the two extensive superphosphate plants and the Ford Works, the position gradually changed until, before the installation of Shell Refinery at the end of 1953, the average total trade in imports and exports more or less balanced each other.

The refinery trade has now turned the scale to an extent where imports predominate, notwithstanding the very substantial exportation, interstate, of refined spirit and fuel oil. With the operation, expected in about September of 1955, of the catalytic plant now nearing completion, this trend is expected to be accentuated.

Apart from refinery products (outward), and coal, steel and pig iron for local industries (inward), interstate trade has remained almost non-existent since the 1939-45 war. Various reasons are advanced by shipping companies, but the fact remains that interstate general cargo vessels are noticeable by their absence, despite the very considerable cargo offering in that trade by such manufacturers as Fords, International Harvester Co., and others which

Another view of Corio Quay showing reclamation and seawalls, for provision of additional berths, roads, rail sidings and cargo sheds. The first cargo shed, completed October, 1955, is on rectangular white portion at rear of North Berth No. 2, and measures 320-ft. by 90-ft. In right background are Ford Motor Works and small portion of new suburb of Norlane.

Port of Geelong, Victoria—continued

distribute manufactured goods to other States—not to speak of agricultural produce surplus to the district.

The following tables will give an indication of the trade of the port for the years 1950 to 1954, the last completed statistical year of the Trust. It must be borne in mind that wheat (now almost entirely bulk) is a variable: the greatest year in this trade having been 1951, with 613,505 tons. All Victorian export wheat leaves from Geelong.

Imports in Tons

	1950	1951	1952	1953	1954
Overseas					
Crude Oil, Motor Spirits etc.	40515	37855	39393	42116	1201245
Phosphate Rock and Sulphur	392403*	292395	279897	242391	280214
Motor Parts and Vehicles ...	41199	16412	15355	28627	38097
General	15140	25133	18320	32496	23979
	489257	371795	352965	345630	1543535
Interstate and Victoria ...	166136	164234	222313	211952	246480
TOTAL IMPORTS ...	655393	536029	575278	557582	1790015

* Stock piling occurred.

Exports in Tons

	1950	1951	1952	1953	1954
Overseas					
Wheat	559821	613505	280748	258344	397301
Barley	—	45916	29849	47838	53293
Wool (inc. transhipments) ...	22200	17214	18884	16679	10083
Frozen Meat	2289	688	2991	1696	2735
Fuel Oil etc.	—	—	—	—	79457
Other Items	20496	2379	4207	2638	2486
	604806	679702	336679	327195	545355
Interstate and Victoria					
Motor Spirit and Fuel Oil ...	—	—	—	—	373702
Other Items	5618	2491	6036	11883	12588
TOTAL EXPORTS ...	610424	682193	342715	339078	931645
TOTAL TRADE	1265817	1218222	917993	896660	2721660

Shipping in Gross Tons

Overseas	1324115	1179831	1000051	1274788	2317989
Interstate and Victorian ...	236866	224671	265663	352221	355606
TOTAL	1560981	1404502	1265714	1627009	2673595

Port Berthage

The shipping berths of the Port are in two distinct areas. On the City side, to the south, are at present two piers: Cunningham Pier, with direct rail access with six tracks—used almost exclusively for coal discharge and for loading of barley and oats, plus from time to time the topping up of bulk wheat vessels with a small tonnage of bagged wheat. Yarra Pier has roadway access only, and usually accommodates overseas vessels discharging general cargo. For this, or any other position in the port, the Trust operates a 25-ton floating crane for heavy lifts within its capacity.

The other general group of berthages are northward of the city proper and at present are, in northerly order: Bulk Wheat Pier (exclusive to that trade); Corio Quay South No. 1 (frozen meat—formerly also bulk motor spirit etc.); No. 2 (superphosphate components—phosphate rock and sulphur); Corio Quay North No. 1 (General Cargo—but to be reconstructed); No. 2 (General Cargo);

Trust Diesel Tugs ("Spencer Nall," 1300 H.P. and "H. A. Lumb" 700 H.P.) berthing large overseas vessel at Yarra Pier.

Typical Peine pile mooring dolphin at Refinery Pier, designed for flexibility in two directions.

Lascelles Wharf (superphosphate components); Kings Wharf (steel and allied cargoes); Refinery Pier.

The following schedule gives some further detail. All have a minimum depth of 32-ft. at low water, with draft of 30-ft.—except Yarra Pier (29-ft., 27-ft. 6-in.):—

Pier or Wharf	Length Ft.	Width Ft.	Deck	Ht. above low water	Remarks
Cunningham Pier ...	1073	90	Timber	12	6 rail tracks, 4 berths
Yarra Pier	831	92	Concrete (Timber aprons)	9	2 berths
Bulk Wheat Pier ...	550	44	Timber	15	2 berths
Corio Quay Sth. 1 ...	420	20	Timber	15	1 berth
Corio Quay Sth. 2 ...	478	20	Timber	15	1 berth
Corio Quay Nth. 1 ...	560	30	Timber	15	1 berth (to be reconstructed 12-ft.)
Corio Quay Nth. 2 ...	560	64	Timber	15	1 berth
Lascelles Wharf ...	530	43	Timber	15	1 berth
Kings Wharf ...	560	50	Concrete	12	1 berth
Refinery Pier ...	75	88	Concrete	12	2 berths (with approach jetty and mooring dolphins)

As mentioned earlier, additional berthage, with reconstruction of Corio Quay North No. 1, is almost ready for commencement in continuation westward of No. 1 (primarily for coal discharge to relieve the city area of this trade and to shorten time in port), with a later further projected general cargo berth across the west end of Corio Quay. Consideration has recently also been given to the advisability of providing an additional berth or berths for general cargo in the City area. The virtual duplication of Refinery Pier berthage is also imminent.

Revenue

Before concentrating on the results, a brief summary of some of the rapidly growing and extremely varied industrial and other activities of Geelong and District will indicate that the position of the port is indeed a sound one, and one in which optimism for the future is justified:

Among the many industries are:—

Motor vehicle manufacture and assembly
Automotive castings
Agricultural implements and tractors
Bulk wheat terminal
Cement manufacture
Woollen and worsted manufacture
Superphosphate manufacture
Rope works
Glass works
Wire drawing works
Spring manufacture
Slipper and shoe factories
Oil refining
Bagged grain depot (export)

(concluded at foot of following page)

Navigational Aid for Small Harbours

Microwave Course Beacon

The use of microwave radar as a marine navigational aid has become well established in recent years, and the X-band search radar is now a recognised fitment in medium and large ships.

Recently attention has been given to producing an apparatus to assist much smaller craft such as coastal fishing smacks etc. The main problem with this type of vessel is the approach to a small harbour, often under conditions of poor visibility, and it is for this application that the Microwave Course Beacon has been developed.

The requirements of the equipment include thorough reliability, robustness, and as small a size as possible for the ship board installation. The system was developed by the Admiralty Signal and Radar Establishment on behalf of the Ministry of Transport.

The essential feature of the Microwave Course Plotter is that the transmitter, which is inevitably somewhat bulky and requires a supply of electrical power from the mains, is installed on shore, while the ship merely has to carry a very small battery-operated receiver. This sets a distinct advantage over shipborne radar.

The principle of operation is that the shore beacon transmits from two aerials, each providing a beam of signal, one coded Morse in " V's", the other in " B's". These two beams are arranged side by side with a narrow overlap, along the centre of which the signals add to provide a continuous signal in which neither V's nor B's are distinguishable. This continuous signal provides a path of direct approach to the harbour, and is usually made about one degree wide. The transmitter has sufficient power to ensure reliable reception at distances of up to seven miles, using a very simple receiver.

The method of operation of the equipment is as follows. The shorebased beacon is set up at the harbour entrance (or any other suitable position), and the aerial system is aligned so that the area of overlap of the two keyed beams lies along the most suitable course for an approach to the particular harbour concerned. A ship requiring to home on to the harbour has simply to switch on its receiver and rotate its aerial until the " B " **or** " V " signal is picked up. The operator then turns his receiver until maximum signal is heard in the headphones, and the ship can home on to the beacon in the direction of loudest signal. To find the course line, the ship now steers to port or starboard (according to whether it is in the " B " or " V " area of the signal) until the equi-signal path is reached. From this point steering may be continued by normal compass means, using the received beacon signal as a check that course is being maintained.

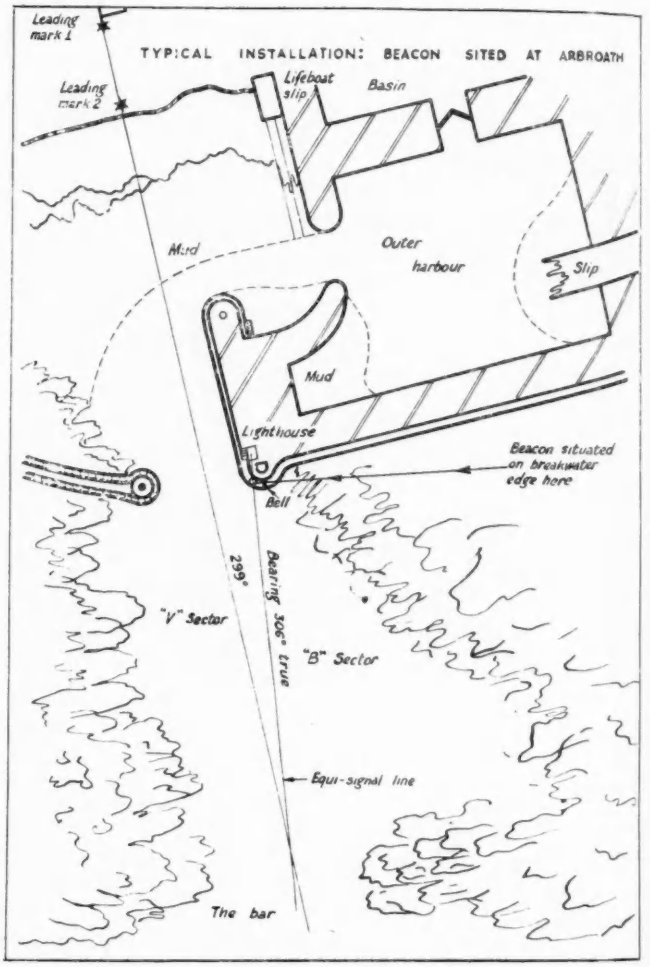


Fig. 3. Plan of Arbroath showing location of micro-wave transmitter.

The harbour transmitter measures approximately 2-ft. by 2-ft. by 2-ft., plus the aerial system which extends a further 5-ft. The total weight is approximately 80 lb., and the power supply required is approximately 100 watts from 230-v.,50 c/s mains. Very little

Port of Geelong, Victoria—*continued*

The principal form of revenue is that from a wharfage rate on goods imported—5s. per ton from overseas and 3s. 9d. per ton from interstate (with interstate coal at 2s. 6d. per ton). There is no wharfage rate on exported goods.

In addition, each vessel is charged a tonnage rate of 1d. per day per gross ton (interstate vessels 3s. 4½d. per gross ton). The following is a condensation of the Revenue Account for 1953 and 1954 respectively. Revenue figures for 1955 are, date to date, considerably higher.

	1953 £		1954 £	
Harbour Revenue	114092		403482	
Shipping Services	45648		78458	
Other Revenue	41448		42307	
		201188		524247
Non-operating Revenue ...		23413		20154
		224601		544401
Less: Operating Expenses				
Admin. and General	44460		47660	
Shipping Services	33656		70449	
Maintenance	53220		59253	
Depreciation	38886		46838	
	170222		224200	
Non-operating Expenses:				
General	6333		10555	
Interest	22046		111283	
		198601		346038
NET REVENUE		26000		198363
Appropriations to various Funds reduce these to ...		14563		173961
Accumulated Revenue Surplus		197930		371891

Assets of the Trust at 31.12.1954 (before deducting in each relevant instance the accumulating provision for depreciation) showed a book value of £4,810,628.

Against this were liabilities, principally inscribed stock and debentures, of £2,829,914.

Endowments, reserves, provisions and accumulated revenue surpluses cover the difference of £1,980,714—a particularly sound proposition for any public authority, taking into account, moreover, the large assured annual revenue.

It is not so long ago that Geelong celebrated its centenary. The second century of its existence has so far been a period of general advancement, and its continued progress appears to be assured.

Navigational Aid for Small Harbours—continued

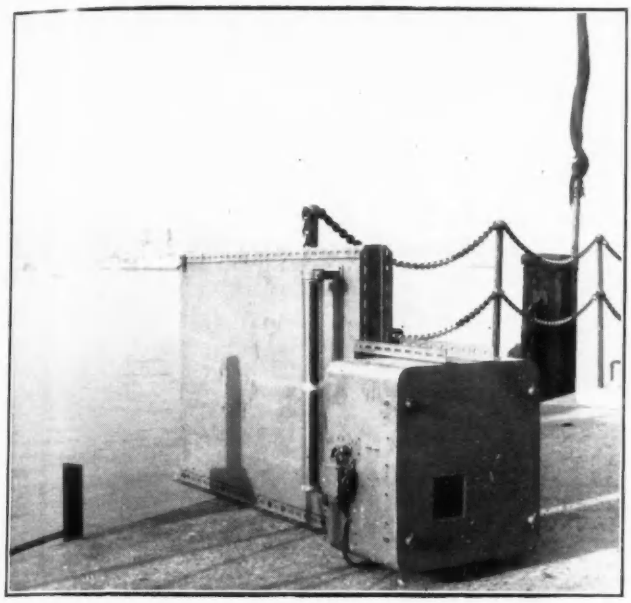


Fig. 1. Micro-wave transmitter mounted on a pier head.

installation is required apart from siting the beam in the correct direction and rigidly fixing the transmitter.

The ship's receiver is very simple and reliable, having no valves whatsoever. It measures approximately 5-in. by 5-in. by 5-in., and can either be portable, enabling it to be taken on board by a pilot, or it can be mounted permanently in a vessel by means of a small searchlight mount, which is convenient from the point of view of obtaining direction. The battery used is a standard torch type, and has a life of at least six months.

The equipment has been very successfully demonstrated to the Harbour Authorities at Arbroath, and after one demonstration the skipper of a small fishing boat was able to assist a large vessel into harbour by contacting it on the radio telephone and, using his homing receiver, leading it in.

The makers of the installation described above are Elliott Bros. (London) Ltd., Century Works, London, S.E.13.

Fig. 2. The portable micro-wave receiver.

Dock Labour in New Zealand

Annual Report of the Waterfront Industry Commission

General Survey. The substantial improvement in rates of work and turn-round of shipping brought about after the 1951 strike have been maintained during the year ended 31st March, 1955. Rates of work have increased slightly as compared with last year with a corresponding increase in profit earned under the co-operative contracting system, which reached an all-time record distribution of £929,760, equivalent to 1s. 9.75d. per hour. There were no stoppages of work through industrial disputes, and the only lost time was through two unauthorised extensions of stop-work meetings, one at Auckland and the other at Wellington, involving a loss of only 2,574 man-hours, as compared with 14,308,612 man-hours worked.

The number of days spent on the New Zealand coast by overseas refrigerated vessels was approximately the same as last year, but as the average tonnage handled per vessel increased it is estimated that, compared with last year, there has been a saving of 2½ days per vessel for vessels discharging and loading and 1¾ days per vessel for vessels loading only. The average tonnage of cargo handled per ship-working day, which increased from 362 tons in 1952-53 to 402 tons in 1953-54, further increased to 426 tons for the year ended 31st March, 1955.

The total cargo handled at New Zealand ports for the year ended 31st March, 1955, was 10,435,000 tons, as compared with 9,346,000 tons in 1953-54, an increase of 1,089,000 tons. The cargo handled per worker per annum increased from 1,510 tons in 1953-54 to 1,605 tons in 1954-55. It is of interest to record that in 1950-51 a total of 7,915 workers handled 8,348,000 tons of cargo or an average of 1,055 tons per worker, as compared with 10,435,000 tons handled by 6,501 workers in 1954-55 at an average of 1,605 tons per worker. In fact, 2,087,000 more tons of cargo were handled in 1954-55 with 1,414 less workers as compared with 1950-51.

The Tribunal's General Principal Order as to wages and conditions of employment expired on 31st August, 1954. Negotiations between employers and workers for a new order resulted in a substantial measure of agreement. The matters not agreed to were referred to the Waterfront Industry Tribunal, the main matters in dispute being rates of pay and the application of a superannuation or pension scheme to waterside workers.

The continued efficiency of the waterfront industry which is so important to the economic welfare of the country is largely dependent on—

(a) The maintenance of good industrial relations between employers and workers.

(b) The continued appreciation by the workers of their contracting or incentive payment system and the return by the worker of a "good day's work" for a "good day's pay."

(c) Adequate and continuing supervision by the employers to ensure that men work the full hours for which they are paid.

The harmonious relations which existed between employers and workers showed some deterioration during the year, more particularly at the port of Auckland. It is important that good relations be re-established at all ports.

The increased bonus payments under the co-operative contracting system indicate that the men are fully aware as to the advantages of the system. For some years the Commission has recommended that there should be a comprehensive review of contract rates with the object of securing, so far as is possible, an equal return for equal effort and the inclusion in the revised contract rates of non-cargo working time. This would provide an incentive to the worker to reduce delays and time taken in handling hatches, etc., which are now paid for on a wage basis. No progress was made during the year to revise the contract rates in accordance with the Commission's recommendations, but it is expected that a revised contract will be given a trial at one or more ports during the next year. The supervision of the men is the responsibility of the employers. There has been a tendency at some ports for men to be allowed to start late and finish early and if this is allowed to drift it will result in a reduction in the cargo handled per day and a deterioration in the turn-round of shipping.

Dock Labour in New Zealand—continued

To assist waterside workers to provide for payment of income tax on due date the Commission has introduced a P.A.Y.E. or instalment system for payment of tax. A large number of waterside workers throughout New Zealand have availed themselves of this service, deductions being made by the Commission from the worker's wages each week.

Payment of wages at ships' sides by pay van has operated at Wellington for over twelve months. This method of pay has resulted in considerable savings in delays to ships and has recently been extended to the port of Dunedin with benefit to the industry. Arrangements are being made to adopt this system of pay at Auckland.

Availability of Labour. The effective or working strength in respect of the port limitation of registered workers for the year ended 31st March, 1955, was 89.78 per cent. as compared with 88.08 per cent. for the year ended 31st March, 1954. There were no serious delays to shipping during the year through labour shortages.

To overcome the shortage of deckmen (hatchmen and winchmen) deck training schemes have been introduced at certain ports. The Commission meets the cost of training deckmen from the National Administration Fund. The cost last year was £1,057. Preference is given to the employment of registered workers, but there is no restriction on the engagement of non-registered workers, including the crews of vessels, when registered labour is not available. The numbers of non-registered workers available for employment vary considerably between ports. The percentages of hours worked by non-registered workers at all ports to total hours worked for the years ended 31st March, 1949, to 1955, are shown hereunder:

	Percentage		Percentage
1949	10.83	1953	6.7
1950	12.16	1954	5.46
1951	11.36	1955	7.84
1952	6.75		

Admissions to and Removals from Bureau Registers. Excluding transfers between registers of 457, a total of 1,586 men were admitted and a total of 1,377 men were removed from the bureau registers during the year. The names of 1,128 men were removed for non-disciplinary reasons, of which 1,073 left the industry, 35 died, and 20 retired. The return shows the very substantial turnover in labour at the Port of Wellington, particularly in respect to the permanent union.

The names of 249 men were removed from the bureau registers for all ports during the year for disciplinary reasons. Included in that number were 108 for unauthorised or unexplained absence, 26 for repeated bureau penalties, 23 for pillage and theft, 13 for misconduct, 17 for inefficiency and general unsuitability, and 62 for physical incapacity or medical reasons.

A total of 84 men appealed to Port Conciliation Committees against the removal of their names from the registers. Of that number 17 appeals were allowed, 22 were allowed conditionally, and 45 were disallowed.

Age Classification. Of the 5,994 men on the bureau registers at all ports at 31st March, 1955, 4,682 or 78¼ per cent. were under age 50 and 1,312 or 21¾ per cent. were 50 years or over. At 31st March, 1954, 76½ per cent. of men on registers were under age 50 and 23½ per cent. were 50 years or over.

It is interesting to note from the Annual Report of the National Dock Labour Board for the year ended 31st December, 1954, that approximately 60 per cent. of dockers in the United Kingdom were under 50 years of age as compared with 78¼ per cent. in New Zealand. The effective or working strength of 89.78 per cent. is slightly better than the figure of last year of 88.08 per cent.

Accidents Involving the Payment of Compensation. It is gratifying to record that there has been a considerable improvement during the year in the number of registered workers absent on compensation and the average time lost through accidents involving the payment of compensation. The improvement is no doubt due to the work of Safety Committees, appointed at a number of ports and the efficient service given to injured workers by the first-aid clinics at the four main ports. Increasing numbers of waterside workers are also using gloves which are made available by the Commission at a subsidised price. The Cargo Workers' Union at Auckland has also allocated a considerable sum of money from the Union's Port Retention Fund to subsidise the purchase of safety footwear for its members and this has had the effect of reducing accidents at that port.

Profit Distribution. The profit distributed under the co-operative contracting system was £929,760, as compared with £788,125 paid out for the year 1953-54, and the average rate of profit increased from 1s. 8.2d. per paid hour in 1953-54 to 1s. 9.75d. per paid hour in 1954-55. In addition, bonuses paid under employers' incentive schemes increased from £27,926 in 1953-54 to £41,079 in 1954-55.

Hours of Work and Average Earnings. For the year 1954-55 the average hours of work per week were 45 (33¾ ordinary time and 11¼ overtime), as compared with 43¾ (33 ordinary time and 10¾ overtime) for the year 1953-54. The highest average was at Whangarei, where the workers averaged 34½ hours ordinary time and 15¼ hours overtime, a total of 49¾ hours per week.

The average weekly wage for all ports increased from £16 15s. 1d. (including £2 17s. 10d. average profit) for the year 1953-54 to £18 9s. 2d. (including £3 4s. 5d. average profit) for the year 1954-55. The highest average weekly wage was earned at the port of Auckland, where the men averaged £19 19s. 9d. per week, which included an average of £4 1s. 6d. per week profit under the co-operative contracting system. At the port of Wellington the permanent section of the bureau register earned an average of £19 17s. per week, which included an average of £3 2s. 6d. per week profit.

New Shipyard for the Bahamas

Plans for a £12,000,000 shipyard to be constructed on the island of Grand Bahama were announced on November 30 by the Earl of Ranfurly, Governor of the Bahamas Islands. The shipyard, capable of handling the world's largest vessels, is the first industrial project in the development of the island's "Freeport."

Freeport is a new area, created by Bahamian legislation in August, 1955, which offers extraordinary incentives to commerce and industry. The area will be free of all taxation for at least 30 years. Companies and individuals will be exempted from all taxes, corporate and personal, and on property. For 99 years, concerns will not be subject to import, excise stamps or export taxes.

Both projects are being undertaken by the D. K. Ludwig interests. Affiliated interests are National Bulk Carriers, Inc., American Tankers Corporation of Delaware, Seatankers, Inc., and Universe Tankships, Inc. These interests are owners, operators and builders of large super tankers and bulk carriers and have pioneered in the construction of the largest commercial vessels ever built.

Freeport is operated by The Grand Bahama Port Authority, Limited, which was created by The Hawksbill Creek, Grand Bahama (Deep Water Harbour and Industrial Area) Act of 1955. This Act provides for the location of a free port on the Gulf Stream, 75 miles east of Palm Beach, Florida, 127 miles north-east of Miami, Florida, and 140 miles north-west of Nassau. Approximately 50,000 acres of land have been set aside in which manufacturing companies licensed by the Port Authority may operate for a period of 99 years with no export taxes or duties on goods manufactured or partly manufactured or stored within the area.

The licence issued to the D. K. Ludwig interests provides for establishing, maintaining and operating a shipyard, Bahama Shipyards Ltd., for the construction, repair and scrapping of ships and all or any businesses and trades which are both subsidiary to and necessary in connection with the operation of such a shipyard. The licence states: "It is planned to construct two basins in the new industrial area of the Grand Bahama Island large enough to take from 20,000 to 80,000 deadweight ton ships, possibly a third basin sometime after the installation of the first two." The largest shipway is expected to be 1,200-ft. in length and 200-ft. in width and will be able to accommodate the largest vessels.

Bahama Shipyards, Ltd., have agreed to dredge the new deep-water harbour, using their own equipment. They are presently building a specially-designed dredge for this purpose. The harbour will be dredged to a depth of 32-ft. throughout at mean low water. It will have a 250-ft. wide channel and a land-locked turning basin of at least 1,000 by 1,000-ft.

The Hopper Dredge

Its History, Development and Operation

A Review of a Publication by the Office of the Chief of Engineers, U.S. Army.

(Continued from page 231)

In the last instalment the concluding paragraphs were concerned with design. The first section under this heading dealt with design criteria, and this was followed by a section of determination of total external head against which the pump must work. The equations necessary for this determination were enunciated. The following section gives an example of an actual calculation along the lines already described.

3. Example of Determination of Head.

"Fig. 11 shows a layout of the suction and discharge system on the 'Comber' class dredges and will be used to illustrate the methods of computing the elements of head described above."

"Based on the assumption that each pump maintains a velocity in the suction line of 19 fps when pumping 98 cfs of a mixture containing 17 per cent. by volume of sand weighing 110 pounds per cubic foot and that the dredge is operating in sea water, the components of head are computed as follows:

(a) Static Suction Head. In this case, the centreline of the pump is 2-ft. 3-in. below the light waterline and, therefore, the static suction head, considering fresh water alone, is a positive value of this amount. However, when a mixture of the assumed proportion, which has a density of 1.15, is being pumped, the true static head in feet of fresh water must take into account the weight of the material between the point of entrance and the centreline of the pump, in this case a vertical distance of 59-ft. 9-in. Correction must also be made for the specific gravity of sea water. The actual static head is therefore:

$$H_s = 1.025 \times 62 - 1.15 \times 59.75 = 5.1 \text{ ft.}$$

As this a negative value, it must be added to the other components to obtain the total head.

(b) Suction Velocity Head. Applying the formula given in paragraph 2b, the velocity head in feet of fresh water becomes:

$$h_v = 1.15 \times \frac{19 \times 19}{2 \times 32.2} = 6.45\text{-ft.}$$

(c) Suction Friction Head. The length of straight suction pipe is approximately 96-ft. with an inside diameter of 30-in. There are included two bends for each of which an equivalent length of 60-ft. of straight should be allowed. The total equivalent length of suction pipe to be considered is therefore 216-ft. Using the formula given in paragraph 2c, the friction head in feet of fresh water is:

$$h_f = .02 \times \frac{216}{2.5} \times \frac{19 \times 19}{2 \times 32.2} \times \left(1 + \frac{17 - 10}{100}\right) = 10.38\text{-ft.}$$

To this must be added the loss through the ball-joint and the entrance loss at the drag head, which are computed to be 0.56-ft. and 2.8-ft. respectively. The total suction friction head then becomes 13.73-ft.

(d) Total Suction Head. The addition of all suction losses is 25.28-ft. of fresh water, which satisfies the criteria stated in the preceding article. The losses when pumping fresh water would approximate 16.5-ft. which also satisfies the criteria.

(e) Static Discharge Head. The maximum height of the centre of the discharge pipe is 22-ft. 6-in. above the centreline of the pump and therefore the static head is

$$h_s = 22.5 \times 1.15 = 25.9\text{-ft.}$$

(f) Discharge Velocity Head. As the same quantity of mixture must pass through the discharge pipe as comes into the pump and the diameter is reduced from 30-in. to 28-in., the discharge velocity is increased inversely as the square of the diameter and becomes 21.8 fps. The velocity head therefore is

$$h_v = 1.15 \frac{21.8 \times 21.8 - 19 \times 19}{2 \times 32.2} = 2.15\text{-ft.}$$

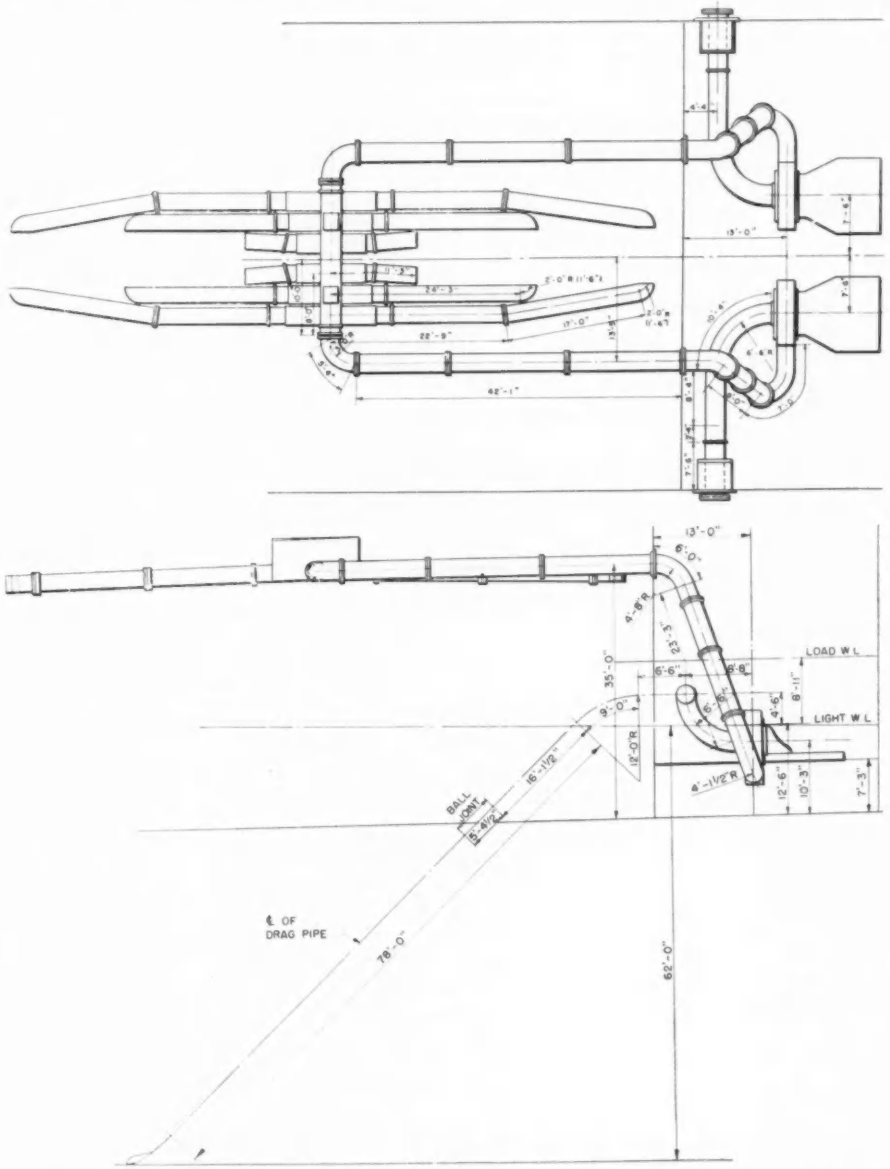


Fig. 11. Comber class dredges—layout of suction and discharge system for dredge pump design.

Hopper Dredge—continued

(g) Discharge Friction Head. For the purposes of this example, the friction head developed between the pump and the distribution box only will be considered. It has been found by experience that the friction head developed beyond this point may be disregarded. There are approximately 66-ft. of straight pipe and three elbows involved or an equivalent length of 248-ft. From the formula, the discharge friction head is

$$h_f = .02 \times \frac{2.48}{2.22} \times \frac{21.8 \times 21.8}{2 \times 32.2} \times (1 + \frac{17-10}{100}) = 16.8\text{-ft.}$$

(h) Total Discharge Head. The total discharge head to be developed by the pump is the sum of the three above components, or 44.85-ft. of fresh water."

4. Suction Pipe Diameter.

"For mechanical reasons, it is desirable to keep the suction pipe size and weight to a minimum, but it must be of sufficient diameter to pass the required quality of material without exceeding the limitation on suction head. The optimum diameter is determined by computing the head losses for a number of sizes within a practical range and selecting the smallest one which complies with the design criteria."

5. Discharge Pipe Diameter.

"The discharge pipe diameter is usually somewhat less than that of the suction pipe and is selected largely from practical considerations of weight and cost. The head losses are not of great importance as the distances are short; however, the velocity must not be too high because the resultant wear becomes excessive. Velocities up to 25 fps. are considered satisfactory in most cases."

6. Impeller Speed and Dimensions.

"To determine the speed and the diameter of the impeller, two factors must be examined. The first is the specific speed, obtained from the formula:

$$N_s = \frac{N\sqrt{Q}}{H^{\frac{3}{4}}}$$

where
N_s = Specific speed, r.p.m.
N = Impeller speed, r.p.m.
Q = Discharge rate, gallons per minute.
H = Total pump head, feet.

The second is the factor K_1 in the formula

$$DN = K_1\sqrt{H}$$

where D is the outside impeller diameter in inches and N and H are as defined above. For hopper dredge pumps, the value of N_s lies between 1,200 and 2,000. The value of K_1 will be between 1,575 and 1,900. Using a value of N_s based on previous experience, a trial value of N is obtained. Similarly, with a value of K_1 based on previous experience, a trial value of the product DN is obtained, which leads to a trial diameter D. Minor adjustments are then made until the other characteristics, values of N_s and K_1 are satisfactory. Table 3 includes, together with other characteristics, values of N_s and K_1 for several pumps."

"For a practical design, the speed of a hopper dredge pump should be between 150 and 300 r.p.m. It is advisable to use the highest speed possible within this range, commensurate with the head to be developed. The fastest pump will have the advantages of least weight and cost, affecting such parts as shafting, bearings and bed plate and the prime mover. This is all the more important where much abrasive material is to be dredged, which will necessitate frequent renewal of pump parts. On the other hand, in a pump of excessive speed, the impeller vanes will be shortened so as to be ineffective, with serious loss of efficiency."

"The diameter of the eye of the impeller should be larger than the diameter of the suction pipe. The dredged mixture changes direction as it enters the pump, being diverted from the axial to the radial flow. To make this change gradual and thus reduce eddies and turbulence as much as possible, the front or suction shroud of the impeller is given a generous radius. This radius is extended into the suction mouthpiece, which is the part between the pump suction head flange and the suction piping. The curve of the front shroud becomes tangent to the suction mouthpiece after extending a short distance within this piece. The back shroud is given a corresponding curvature."

"To establish the minimum width between shrouds, a suitable value must be assumed for the radial component of the absolute velocity with which the dredged mixture emerges from the impeller. Then from the continuity equation Q=AV, it can be established that

$$b = \frac{Q}{\pi \triangle D V_r}$$

where
b = Width between shrouds, ft.
Q = Discharge rate, cu. ft./sec.
D = Outside diameter of impeller, ft.
V_r = Radial flow velocity, ft./sec., at the periphery.
$\triangle$ = A restriction factor allowing for the thickness and number of impeller vanes. Its value is usually between 0.85 and 0.90 and it may be defined as the percentage of the impeller periphery not occupied by the thickness of the vanes.

Table 3 gives values of radial velocity of flow corresponding to a suction pipe velocity of 20-ft. per second for several hopper dredge pumps. In determining the width between

TABLE 3. Hopper Dredge Pump Characteristics.

	DREDGE: GOETHALS	PACIFIC	HARDING	HAINS	COMBER	ESSAYONS
Date of design	1937	1937	1939	1942	1947	1949
Suction nozzle dia., inches	32	20	22	21	30	36
Discharge pipe dia., inches	30	18	20	20	28	32
Impeller dimensions						
Outlet, dia., inches	75	60	56	51	72	84
Eye, dia., inches	33⅞	21	23⅞	21	33⅜	37 9/16
Width between shrouds, inches	18	10	12	13	17	21
Bhp	1,300	340	650	410	1,150	1,850
Max. operating rpm	175	210	250	240	205	180
Disch. rate, cu. ft/sec[1]	111.6	43.6	52.8	48.1	98.1	141.4
Total head, ft.[2]	72	48	76	53	72	81
Number of vanes	5	5	5	5	5	5
Vanes angles, degrees						
Entrance	45	53	45	41	45	45
Exit	50	53	55	49	53	55
Specific speed, rpm.....Ns	1,590	1,610	1,500	1,805	1,735	1,680
Factors						
K_1	1,550	1,815	1,610	1,690	1,740	1,685
K_2	.600	.555	.600	.650	.606	.655
Radial flow from imp., ft/sec.	3.4	3.9	4.3	3.8	3.7	4.1
Approx. thrust load, lbs.	16,500	5,300 (3)	8,500	6,600	17,000	21,000

1 Based on 20 ft./sec. velocity in suction nozzle.

2 Based on 70 percent pump efficiency and discharge rate from preceding line.

3 Laboratory measurement during model tests.

Hopper Dredge—continued

shrouds, it must be borne in mind that a dredge pump must permit solid objects of reasonable size to pass. Consequently, there is a minimum width which can be tolerated. For this reason, the width b is generally compared to the diameter of the discharge pipe, and Table 3 includes a factor K_2 which is the ratio of the width between shrouds to the discharge pipe diameter."

7. Impeller Vanes.

"Impeller vanes in performing their primary functions, also serve to guide the dredged mixture in its passage through the pump. Theoretically, the greater the number of vanes, the more nearly perfect the guidance becomes. However, too many vanes would not only greatly increase the friction loss within the pump, but would also restrict the passage of solid objects through the pump, particularly at the eye of the impeller, where the vanes converge. On the other hand, too few vanes increase the losses due to turbulence, eddies, and recirculatory flow within the pump. Three-vane, four-vane and six-vane impellers have been tried and found less desirable than the five-vane one in present use. Impellers with fewer or more vanes are used only for special purposes."

"The curvature of the vanes is such as to guide the flow through the impeller as smoothly as practicable. This is done principally by assigning definite angles to the points where the dredged mixture makes its first and last contacts with the vanes. These angles are measured between tangents to the vane at the entrance and exit points and radial lines from the centre of the impeller through the points of tangency. They are known as the vane entrance and exit angles."

"If the impeller were standing still, the dredged mixture would enter the impeller radially, and for perfect guidance the vane angle would then be theoretically zero. However, the impeller must rotate, so that the entrance point of the vane has a certain tangential velocity. For the flow to be radial, therefore, the vane must have a backward angle at this point. Also, in practical designs, the prerotation of the mixture at the eye of the impeller cannot be avoided, as a result of which the dredged mixture acquires a small tangential velocity. This velocity due to prerotation, and the radial velocity with which the mixture enters the vane passages, combine to give an entering absolute velocity at an angle other than zero degrees."

"Fig. 12 illustrates the various velocities and angles entering into the design of the impeller vanes. By absolute velocity is meant the velocity of the mixture relative to a fixed point. The relative velocity is the velocity of the mixture relative to the vanes. The absolute velocity is the vector sum of the relative velocity and the tangential velocity. In Fig. 12 the absolute velocity is designated by V, the tangential velocity by U, and the relative velocity by W. The subscripts 1 and 2 denote the entrance and exit points of the vanes, respectively. The entrance and exit angles are denoted by A and B, respectively. The values of these angles determinable from the geometry of the impeller and the known or determinable velocities are not applicable for dredge pumps. Experience has shown that for greater pump efficiency when dredging mixtures, the angles must usually be made larger than the theoretical values. Typical values are shown in Table 3. The exit angle is generally made larger than the entrance angle in order to accommodate the tendency of the flow to increase its deviation from the path prescribed by the vanes as it approaches the periphery of the impeller. After the angles have been determined, it is possible to lay out a vane of single curvature by the method illustrated in Fig. 13. The formulas given in the illustration for the radii R and r can be proven mathematically correct by the application of trigonometric principles."

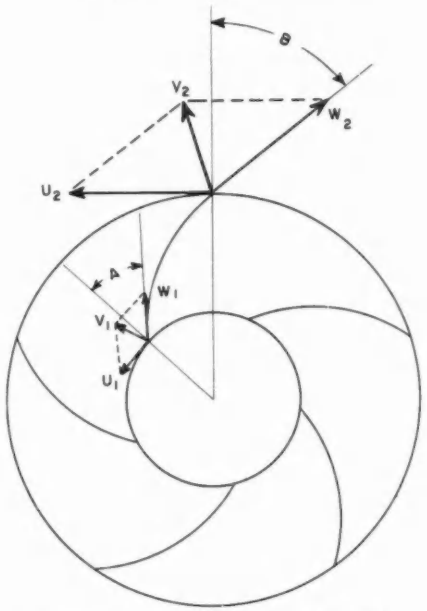


Fig. 12. Diagram illustrating impeller velocities and vane angles.

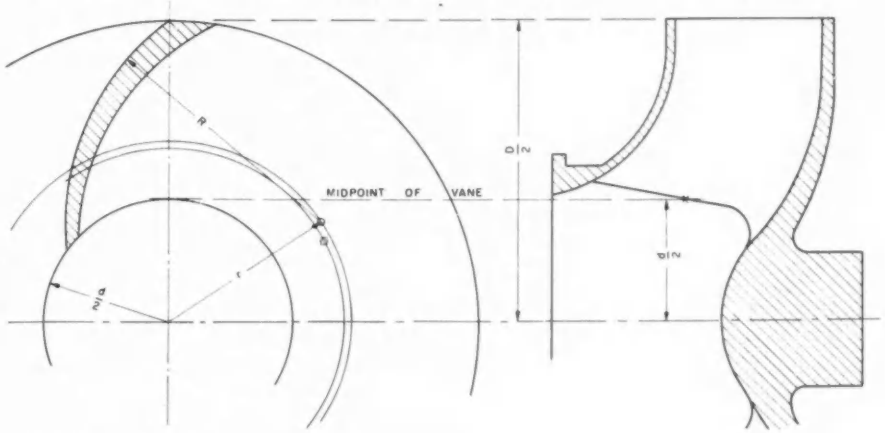
"The vanes of a hopper dredge pump always extend to the periphery of the impeller. They do not usually exend into the eye because, as previously stated, convergence of the vanes at this point is restrictive to the flow of solid objects such as rubbish and stones. The diameter at the inner tips of the vanes is so chosen that the distance between vane tips will at least equal the width between the shrouds."

8. Leakage, Service Water and Thrust.

"Fig. 14 illustrates the leakage path within the conventional dredge pump. On the suction side, the pressure differential developed by the impeller causes flow from the impeller discharge back to the impeller suction through the suction seal. The quantity of leakage which takes place depends upon the pressure differential and in the dimensions and features of the path. In a pump properly designed, the quantity of leakage is in the order of 1 to 2 per cent. of the total quantity being pumped; however, since the seal is one of the areas of rapid wear within a dredge pump, the leakage allowance is usually assumed at 5 to 10 per cent. in design calculations."

"The minimum practical clearance between the impeller and the pump casing is about one-eighth inch, therefore leakage can be reduced only by improving the design of the suction seal. The objective is to increase the resistance which the clearance path offers to leakage flow and two methods are commonly employed, namely, by sudden enlargement for short sections of the path and by the use of passages having abrupt changes in direction. These two features may be seen in the suction seal shown in Fig. 15, used in pumps of the "Comber" class dredges. This seal is an improvement over the ordinary flat plate ring liner usually installed at the impeller eye but entails a greater first cost."

"On the drive side of the pump, a gland is provided to prevent leakage to the outside. Service water is supplied to the water seal ring at a pressure somewhat greater than the



A = ENTRANCE ANGLE

B = EXIT ANGLE

$A_1 = 90° - A$

$B_1 = 90° - B$

d = DIA. OF MIDPOINT CIRCLE

D = IMPELLER DIAMETER

$$R = \frac{D^2 - d^2}{4\,(D \cos B_1 - d \cos A_1)}$$

$$r = \sqrt{\left(R + \frac{D}{2}\right)^2 - RD\left(\cos B_1 + 1\right)}$$

Fig. 13. Diagram illustrating layout of vane curves.

Hopper Dredge—continued

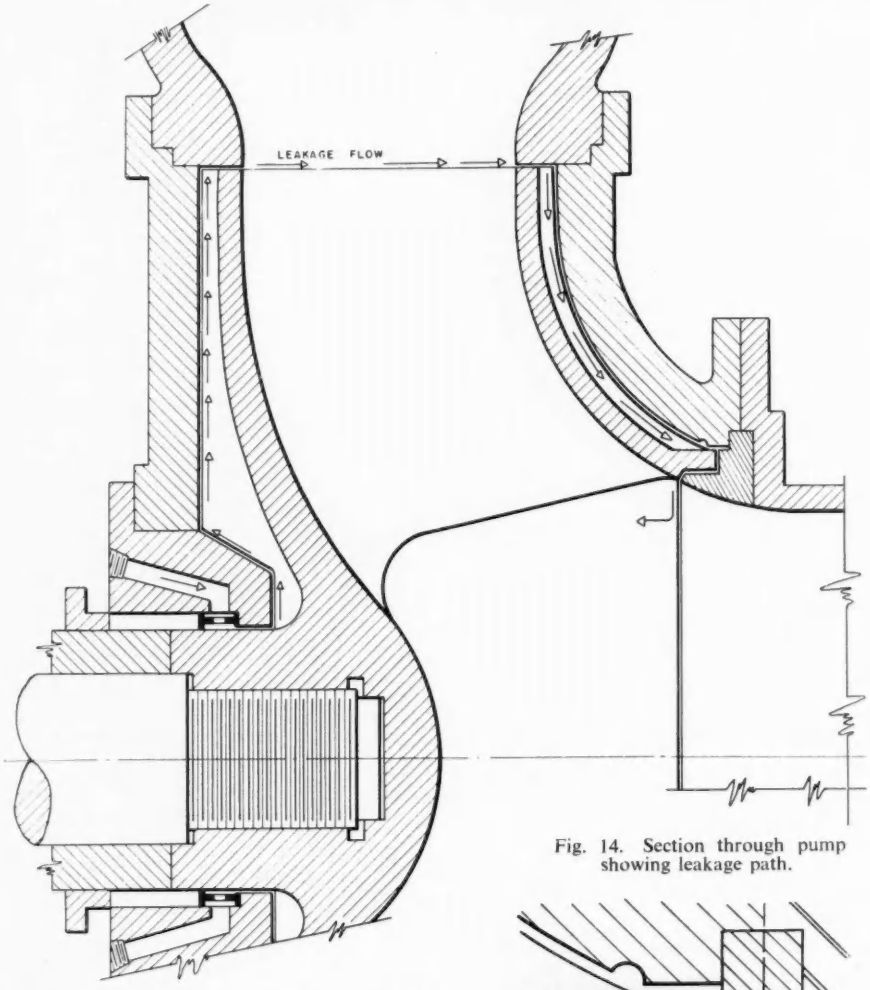


Fig. 14. Section through pump showing leakage path.

head created by the pump and in order to ensure positive flow."

"The function of service water is to prevent abrasive material from reaching the packing gland and on pumps which are not submerged, to seal the gland and assist in the priming operation. The water seal ring within the stuffing box provides an annular space for uniform distribution of water around the impeller hub. On hopper dredges, it is customary to supply service water for the dredge pump from the ship's general service system, usually at a pressure of 40 pounds per square inch."

"The use of vanes or radial ribs on the outside of the shrouds causes flow of the service water in the clearance spaces with consequent generation of pressure opposing the head developed by the impeller thereby reducing leakage, and tends to reduce the amount of sand or other solids in the space between impeller and heads thus reducing wear in this area. The amount of axial thrust in a dredge pump is somewhat affected by the clearances and leakage existing in the pump."

"Fig. 16 illustrates the components which contribute to the axial thrust in a hopper dredge pump, namely:

(a) The thrust due to the dynamic force exerted by the stream as its direction is changed when it enters the impeller. This force can be computed by the following formula:

$$T_D = \frac{WV_o}{g}$$

where

T_D = Dynamic force in pounds.
W = Pounds per second of dredged mixture entering impeller.
V_o = Velocity of mixture in fps, entering eye of impeller.
g = 32.2 fps ps.

The direction of the force T_D is into the pump away from the suction is therefore considered negative.

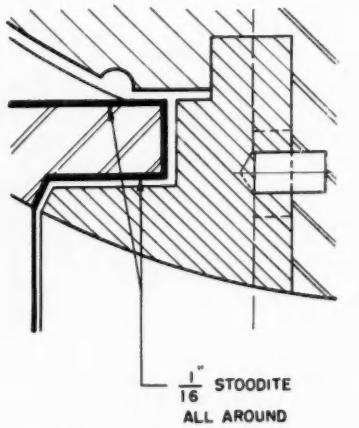


Fig. 15. Comber class dredges —detail of suction seal.

(b) The force acting on the back or driving side shroud of the impeller and generated by the action of the radial ribs cast into the outer surface of the shroud. This force is

$$T_B = 0.000000805N^2(R_2^4 - R_o^4)$$

where

T_B = force on back shroud in pounds.
N = impeller r.p.m.
R_2 = radius of periphery of impeller in inches.
R_o = radius of lowest extension of radial ribs on back shrouds in inches.

The direction of force T_B is toward the suction and is therefore positive.

(c) A force on the front or suction side shroud similar to T_B on the back shroud and created by the radial vanes cast on the outside of the front shroud. This force is

$$T_F = 0.000000805N_2^4(R_2^4 = R_1^4)$$

where

T_F = force on front shroud in pounds.
R_1 = radius of lowest extension of radial ribs on front shroud in inches.
N and R_2 are as defined for T_B

The direction of force T_F is away from the suction and therefore negative.

(d) A force due to the existence of vacuum at the eye of the impeller, acting in a positive direction, i.e. toward the suction. At sea level this force is:

$$T_V = 1.54VR_E^2$$

where

T_V = vacuum force in pounds.
V = vacuum gauge reading in inches of mercury.
R_E = radius of impeller eye in inches.

Inasmuch as a good dredge pump can attain a vacuum of 29in., full vacuum of 30-in. is customarily used in computing this force.

(e) An unbalanced undeterminable force acting between the shrouds within the impeller. For hopper dredge pumps, the allowance for this force is 1.5 pounds for every square inch of projected front shroud area, i.e.

$$T_U = 3.14(1.5)(R_2^2 - R_E^2) = 4.71(R_2^2 - R_E^2)$$

The total thrust can be estimated by combining all five components described above, i.e.

$$T = T_V + T_B - T_F + T_U - T_D$$

The estimated thrust load, computed as above, for the most recent hopper dredge pumps, is included in Table 3, and the forces acting are illustrated in Fig. 16.

In selecting the thrust bearing, an amount should be added to the computed thrust to allow for the inexactness of hydraulic design, the magnitude of which is determined by the experience and judgment of the designer."

9. Casing.

The casing is the most expensive part of the dredge pump, not only because it is the largest and heaviest member but on account of the amount of machining required. The casing is, therefore, designed for strength and

Hopper Dredge—continued

long life. To this end, it is usually made of abrasion resisting alloy steels, heavy in section. In operation, the casing must withstand the impact of heavy stones and other objects transported by the stream.

The casing design greatly affects the efficiency of the pump. In it, the velocity energy created by the impeller must be converted efficiently into pressure energy. Turbulence, eddies, and shock losses are to some extent unavoidable in this process, but large radii and generous fillets are employed to minimise such disturbances. Also the curve of the circumference of the casing is a spiral or volute which provides a waterway of gradually increasing cross-section.

Fig. 17 illustrates the layout of a volute casing in which D represents the outside diameter of the impeller. The transition from velocity to pressure takes place within the volute, outside of the periphery of the impeller.

The form of the volute is capable of precise mathematical computation but can, with only slight departure from the true form, be determined more easily and with less labour by empirical means. Certain important conditions must be established before laying out the volute. First, the outlet section of the casing must have an area not less than that of the discharge pipe, but may be larger depending upon the discharge head and the pump application. Second, the throat section of the casing must have sufficient dimensions to prevent clogging. In modern hopper dredge pumps, the area of this section is about 65 per cent. of the discharge pipe area.

The dimensions a and b are determined by laying out the cross-sections of the proposed volute at the outlet and throat sections following the above criteria. By trial and error, two radii, R_1 and R_2, whose centres are on the vertical centreline equidistant from the horizontal centreline, and whose arcs will become tangent at point X, are found, and their arcs are inscribed to form the interior periphery of the volute.

The cross-sections of the casing in the modern pump are approximately rectangular with large corner radii.

10. Efficiency.

In a dredge pump, there are hydraulic losses, leakage losses and mechanical losses. The hydraulic losses include those due to eddies, turbulence, shock, and fluid friction. They can be reduced, but not entirely eliminated, by proper design featuring the use of easy curves, generous radii and large fillets, and avoiding sudden changes in section or abrupt changes in direction. The total head generated by the impeller is higher than that actually measured at the pump. The extra head is consumed within the pump to overcome the hydraulic losses. The hydraulic efficiency of a pump is expressed by the equation:

$$e_h = \frac{h}{h_i}$$

where h is the total head measured at the pump and h_i is the total head actually generated by the impeller.

The volumetric efficiency of a pump is expressed as:

$$e_v = \frac{Q}{Q+Q_L}$$

where Q is the delivered discharge rate of the pump and Q_L is the amount of leakage through the clearance spaces.

The mechanical losses of a pump include those in bearings and stuffing boxes and disc friction. This friction is the resistance set up by rotation of the impeller in the fluid in the pump. The presence of solids in the dredged mixture makes the disc friction loss for a dredge pump considerably greater than it would be for an ordinary water pump.

If e_m denotes the mechanical efficiency and E the gross or overall efficiency of the dredge pump, then

$$E = e_h \times e_v \times e_m$$

When speaking of pump efficiency, it is the gross efficiency that it is usually meant. This

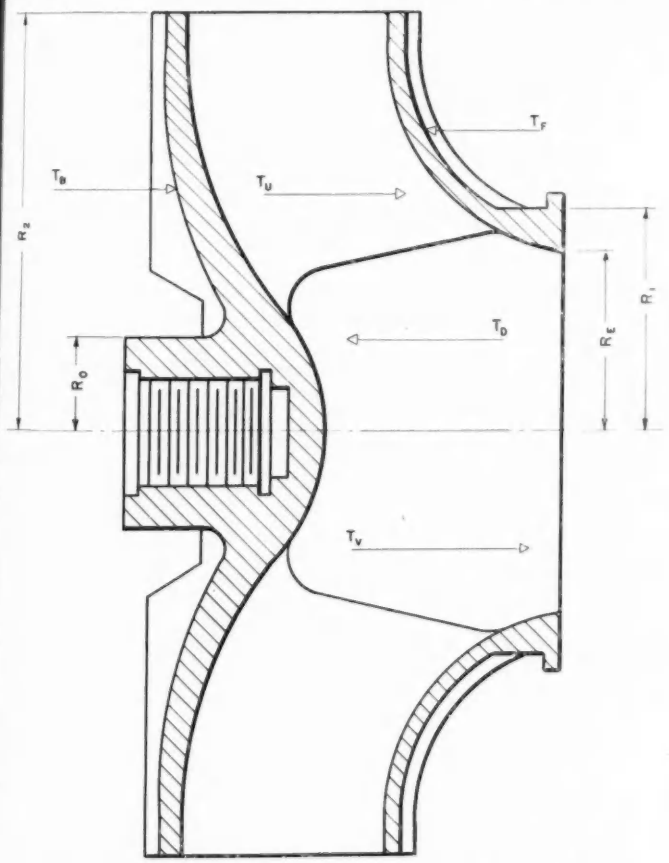


Fig. 16 (above). Diagram of thrust forces in a dredging pump.

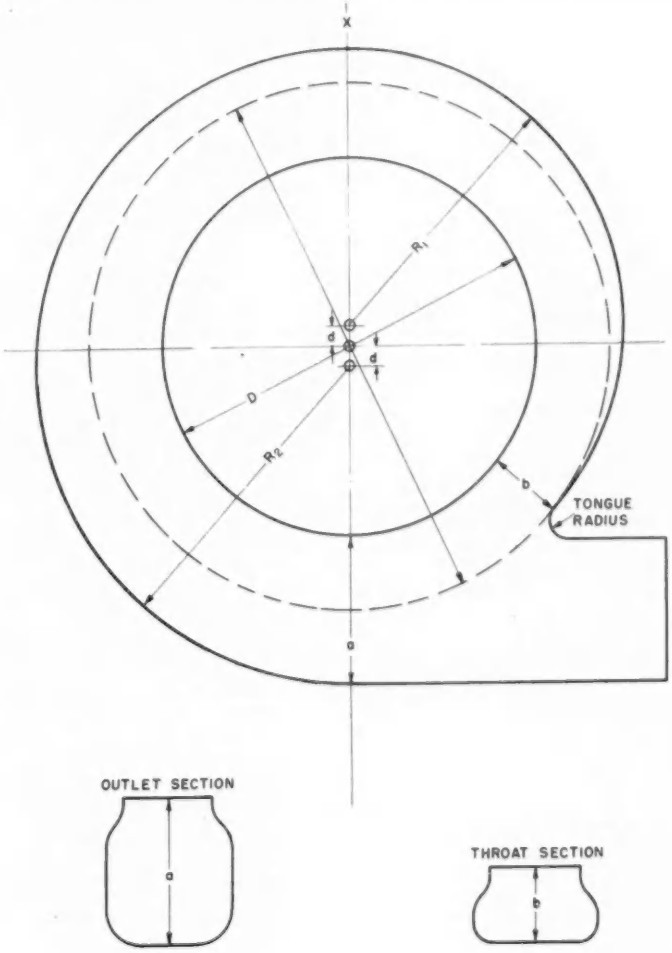


Fig. 17 (right). Diagram illustrating layout of volute.

Hopper Dredge—continued

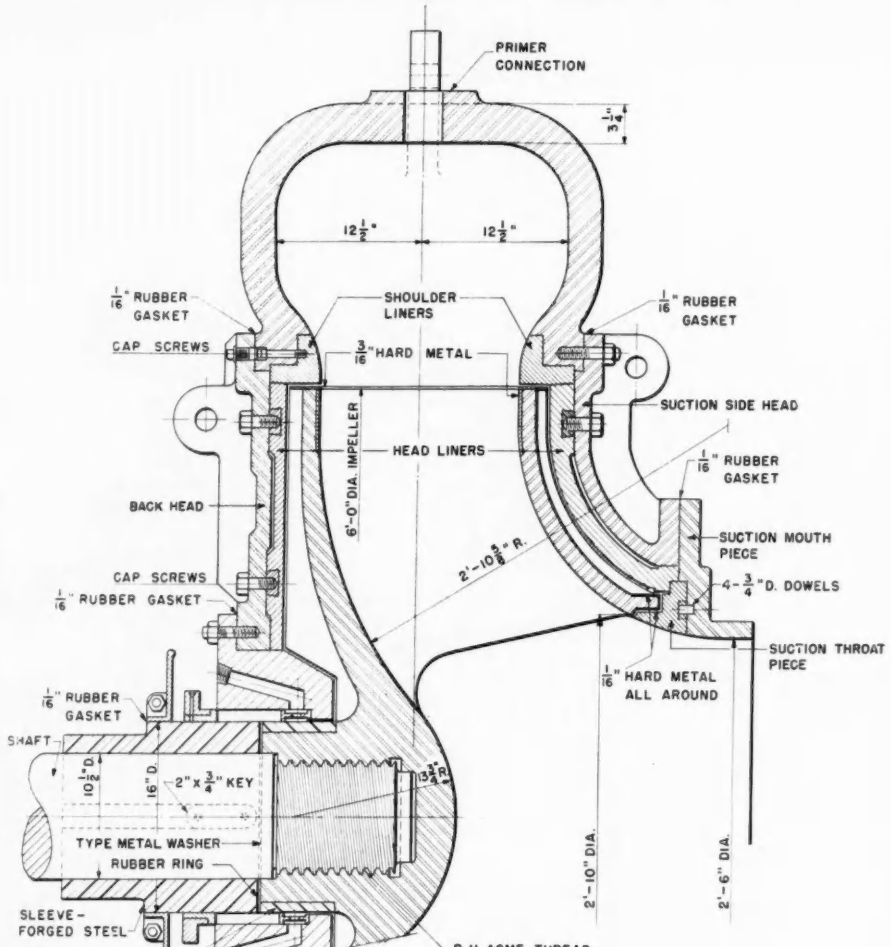


Fig. 18. Comber class dredges—vertical cross-section of dredging pump.

is the efficiency used in the formula:

$$Bhp = \frac{QWH}{550E}$$

where

Bhp = brake horsepower required to drive pump.
Q = discharge rate, cfs.
W = weight of water, lbs./cu. ft. (62.4).
H = total head against which the impeller pumps, feet of water.
E = gross efficiency."

Construction.

The dredge pump of the "Comber," which is illustrated in part in Fig. 18, is representative of modern pumps, designed for resistance to wear and accessibility for maintenance and renewal of wearing surface. Some salient features of the construction are as follows: The easy radius of the passages of the double shrouded impeller which is five-bladed; the hub of the impeller is threaded and the impeller screwed on to the shaft; the shaft lands on a soft "type metal" washer backed by a rubber ring to prevent leakage; the eye and periphery of the impeller, critical wearing points, are faced with hard wearing material which can be deposited by welding.

Removal of the suction mouthpiece gives access to the throat piece. The suction side head is next removed followed by the front head liners. The front impeller shroud is now revealed. By removing the top half of the casing the shoulder liners are now accessible and on removing these, the impeller may be dis-assembled, giving access to the back head liners. The liners have mild steel inserts threaded to receive tap bolts which fasten them to the heads, thus obviating the need for the fastenings to penetrate through to the wearing side of the liners.

The liners are of alloy cast iron, Brinell number 500, tensile strength 50,000 lbs. per sq. in. The impeller top and bottom halves of the casing are of hard cast steel. Quenched and tempered steel forgings are used for the shaft and sleeves.

Capacity. The optimum maximum pump capacity has been found by experience to be related to the surface area over which the discharged material must travel before reaching the overflows, a ratio of 2.5 cubic feet per minute per square foot of hopper surface area for maximum capacity having proved suitable. In the "Comber" where the ratio is 3.4 to 1 the excess capacity has proved of little value.

Pump Drive. A dredge pump is inherently a slow speed mechanism, ranging from 150 to 300 r.p.m., for which the power requirements are not great. The highest powered pumps in the Corps' dredges (in the "Essayons") are each driven by an 1,850 h.p. motor. The direct current, shunt wound motor, with variable voltage and field control most nearly meets the requirements of reliability, remote control and variable speed.

(To be Continued)

Timber Shipment in Sweden

Co-Ordination of Stevedoring Arrangements

In an endeavour to improve conditions at ports in Northern Sweden, representatives of the Swedish shipowners, stevedore companies, ship's agents, importers and exporters, including sawmills and woodpulp mills, have met together on several occasions and have now agreed on practical measures aiming at spreading shipments as evenly as possible over the shipping season, so as to avoid congestion and ensure steadier employment over the whole season for the registered stevedore labourers.

A joint statement issued by the Swedish Shipowners' Association, the North of Sweden Stevedores' Association and the Swedish Timber Exporters' Association announces the steps suggested to improve conditions:

(a) the sawmills agree to do their utmost to spread shipments;
(b) the sawmills, when practicable, will sell cargoes and fix vessels subject to stem. In the case of f.o.b. sales, buyers and charterers abroad will thus have to make sure that the sawmill will be able to load within a certain, comparatively brief, period, according to one suggestion 20 days;
(c) the principal mills and industrial concerns in the various districts will co-operate as far as possible so that the labour requirements in the whole district may be co-ordinated;
(d) the local stevedoring companies will act as a kind of "centre" for receiving information on the expected movement of vessels and the labour required;
(e) Swedish shipowners, their captains and agents will pay the utmost attention to the importance of notice being given of the expected time of arrival of vessels, any changes in the expected time of arrival, the stowage of the cargo, the number of gangs actually needed, and so forth, in order that lack of advice of this nature will not waste labour and time.

In a Special Circular to members The Baltic and International Maritime Conference writes that any measures taken to improve the turn-round are, of course, most welcome to shipowners. On that account the Conference supports those outlined above and asks members trading with Sweden to do so individually.

Pneumatic and Similar Breakwaters

Model Experiments Using Surface Currents

By J. T. EVANS. O.B.E., M.I.C.E.
(Director of the Docks and Inland Waterways Research Station)

Introduction

IN the early years of the present century Mr. Philip Brasher, an American, first developed and patented a process for calming waves by injecting air bubbles beneath the surface. His method was used with success for some years after 1915 to protect from wave action a pier of the Standard Oil Company at El Segundo, California[1]. Other installations were made but they were not all so effective. The mechanism of the method was unknown and very varied suggestions were made to explain how the bubbles calmed the waves. The performance of the method could not be predicted and it fell into disuse.

Since that time both the effectiveness of the method and the mechanism by which it sometimes calms the waves have been debated and laboratory experiments have been made but no generally accepted conclusions have yet been reached about its value or about the reasons for its occasional success. If its behaviour in given circumstances could be predicted it might be of value to civil engineers.

In 1924 an investigation was conducted at the Admiralty Experiment Works, Haslar, with waves from 5-ft. to 40-ft. long and up to 6-in. high. It was noted that the method seemed to accelerate breaking of the waves but no mechanism was suggested to show how this might be brought about. It was concluded that the method would be effective in exposed moderately shallow coastal waters[2].

In 1935 the Russian Central Scientific Research Institute for Water Transport published an account of experiments made in a tank 11-ft. deep with waves up to 7-ft. long. It was concluded however that the rules governing the effect of compressed air upon the waves remained so far undiscovered[3].

In 1936 Professor Thijsse, of Delft, experimented with the pneumatic breakwater and found that the quantity of air needed for efficient damping would be very great. Professor Thijsse suggested that the operating factor in calming waves was not the bubbles as such but the currents of water set up by the bubbles first rising vertically from the air pipe (laid parallel to the wave crests) and then flowing out horizontally from each side of the rising column of air and water[4].

In 1942 Sir Geoffrey I. Taylor and Professor C. M. White each put forward this same suggestion.

Sir Geoffrey Taylor analysed mathematically the effect of a surface current and showed that all waves shorter than a given wavelength could be stopped by an opposing surface current of a calculable velocity depending on its thickness[5]. Professor White investigated the problem mainly by experiment, using both air injection and water jets, and the results confirmed that wave barriers were practicable but only just so[6].

In the same year Mr. P. J. H. Unna, a civil engineer, showed analytically that thick horizontal opposing currents should prevent the propagation of waves shorter than a limiting wavelength[7].

In 1950 Professor A. W. Carr of the California Institute of Technology carried out tests in a tank with 13-in. of water using waves from 1-ft. 6-in. to 5-ft. in length. Currents were produced both by air bubbles and by water jets. Professor Carr concluded that the large power required to calm long waves made the method of little practical importance[8].

The present Note describes experiments carried out in 1953 and 1954 which show that a thin horizontal opposing surface current, of a given velocity profile, has almost the same effect in wave stopping whether it is set up by air injection or by water jets. This observation is taken to demonstrate that the bubbles as such have at most a very small effect on the wave motion and to confirm the suggestions made earlier. The experimental results have been published elsewhere[11]. The present Note goes on to give methods of calculating the horsepower of the opposing current required to stop waves, or to lower them to any required height, given their length, height, the depth of water and the thickness of the surface current.

The Dover Installation

In March, 1952, when the outer dock gate at Dover Train Ferry Dock was due to be taken away for repair the Dock Engineer of Southampton, who was concerned with the work, suggested that a pneumatic breakwater might be used to protect the inner gate from wave impact during the time that it would be operating alone and he asked the Research Department of the British Transport Commission, Docks and Inland Waterways, to find out what could be done. The Research Department prepared a scheme for this site based on the information then available.

While this scheme was under consideration by the Railway Executive, Mr. A. H. Laurie, an oceanographer, writing in "The Dock and Harbour Authority" of May, 1952, gave an account of Brasher's work, and introduced some fresh considerations regarding the modus operandi of pneumatic breakwaters. His company was engaged by the Railway Executive to design and supervise the installation at Dover. Perforated air pipes on the bed of the dock approach channel and a Palouste gas-turbine air compressor were in position ready for use during the last three months of 1952[9]. The equipment was set to work twenty-two times during that period.

Automatic water level recorders showed fluctuations in the water surface while the air was being discharged only slightly lower than without the air. This apparent wave motion was attributed at the time to an oscillation of the body of water between the air discharge pipe and the dock gate, set up by the wave motion but in addition to it. On the other hand it may have been due to a standing wave against the dock gate or simply the incident wave continuing on its course slightly lowered in height.

These records therefore do not warrant a reliable estimate of the amount of wave reduction achieved. Nevertheless the Railway operating staff reported that the dock gate was successfully opened and shut by its motor on five or six occasions in wave conditions that would have prevented the work if the pneumatic breakwater had not been used.

Present Investigations

It thus appeared that the method was not entirely without value and the Research Officer of the Docks and Inland Waterways undertook to investigate the subject and find out if possible how the method worked and the extent of the circumstances in which it would be successful.

Object of the Investigation.

It was hoped that the investigation would clear up the uncertainty which had faced civil engineers for forty years in considering the possible use of the pneumatic breakwater. So varied have been its effects and so little is known about its method of working that engineers have been chary of using it. It was thought that the investigation might indicate the conditions, if any, in which the method could be successfully used in practice.

If the investigation showed that the method was effective and economical it might be useful for calming waves locally and temporarily in places where navigation or berthing is awkward, without interfering with the free movement of shipping; for the protection of maritime civil engineering works in progress and for salvage work.

If the method was found on investigation to be ineffective or uneconomical there would at least be the gain that engineers need not spend time and money on considering or carrying out full scale installations in the hope, but not the assurance, that they would work.

Experimental Equipment.

In the Hydraulic Laboratory of the British Transport Commission, Docks and Inland Waterways, a wave tank was built 4-ft. wide x 4-ft. deep and 62-ft. long. The water was

Pneumatic and Similar Breakwaters—continued

normally kept 3-ft. deep. A paddle near one end of the tank could generate waves from 2-ft. to 17-ft. long and up to 6-in. high. Air and water were injected at a point near the other end of the tank. A glass window 6-ft. long and the full depth of the tank allowed direct observation of the effect of these injections on waves (Fig. 1).

An air supply of 40 cubic feet per minute was provided at a pressure of 5 pounds per square inch. The air was discharged from perforated pipes and porcelain filters on the bottom of the tank. To discharge 10 C.F.M. from each foot of the width of the tanks the number of perforations ranged from 150 holes each 1/16-in. diameter in the pipes to many thousands of microscopic holes in the filters. There was little difference to the eye in the diameter of the air bubbles throughout this range and less than 10 per cent. difference in the velocity of the resulting surface currents.

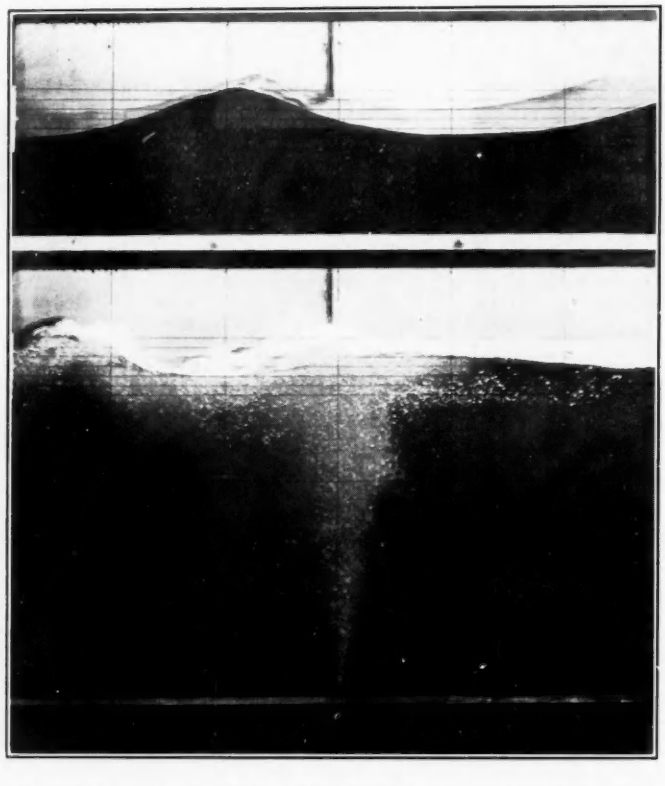


Fig. 1 (left). Wave tank showing (above) wave propagated by paddle and (below) the same wave reduced by pneumatic breakwater.

A water supply of half a cubic foot per second was provided at pressures up to 50 pounds per square inch. The water was drawn from the tank through a perforated suction pipe set horizontally across the tank near the paddle at a depth of 2-ft. 5-in. below normal water level. It was discharged through nozzles of $\frac{1}{4}$-in., $\frac{3}{8}$-in., $\frac{1}{2}$-in., $\frac{3}{4}$-in. and 1-in. diameter. Over the whole range of pressures the $\frac{1}{2}$-in. nozzles gave the fastest surface velocity and the best wave-stopping power. The nozzles were so placed in the tank that the jets of water broke surface vertically over the line of the perforated air pipes. The nozzles were arranged, one to each foot of width of the tank, at 6-in. below the surface and inclined upwards at angles up to 12°. An inclination of 6° gave surface currents of a thickness corresponding to one-tenth of the wavelengths that such currents could stop. An inclination of 8° gave thinner and faster currents corresponding roughly to one twenty-fourth of the wavelengths that such currents could stop. These were the best arrangements of the nozzles: placing them on the bottom of the tank either vertically or inclined towards the oncoming waves at 45° was found less effective.

The surface current varied in thickness from an average of 6-in. with low air and water discharges to 14-in. with the highest discharges available. In all cases the velocity of the horizontal surface current fell uniformly from a maximum of up to 4-ft. per second at the surface to a minimum of about 6-in. per second at the bottom of the current. Below the current were random movements of water of that order of speed.

The surface currents varied in speed and in thickness as they flowed horizontally from a point vertically over the air discharge pipe. After trials it was found most consistent to compare and classify the currents by the maximum velocity attained as they flowed along. At the point of maximum velocity the mean of the velocities over a cross section of the current of thickness $^{L}/_{10}$ and $^{L}/_{24}$ was taken as the measure of the current, where L was the length of the wavelength under examination.

The depth of $^{L}/_{10}$ was selected for the principal investigation because little variation in stopping velocity was found with small changes in depth of current around $^{L}/_{10}$. A shorter series of measurements was made with the current approximately $^{L}/_{24}$ thick.

Wave heights were measured by floats working a pen tracing the wave curves on a continuous strip of paper through a lever reduction of 4 to 1. A pair of floats was used parallel to the wave crest to minimise the effect of transverse oscillations set up by some waves. For each reading of wave height a run of about one hundred waves was observed. The height recorded was the average of the highest one third of these hundred waves. The result was estimated to be accurate to 3 per cent. of the higher waves examined. Wave heights were measured far enough from the breakwater to avoid the local effect of any current on its protected side. The height referred to is the total height from trough to crest. Fig. 3 shows examples of the traces of waves set up by the paddle and lowered by air and by water injection respectively.

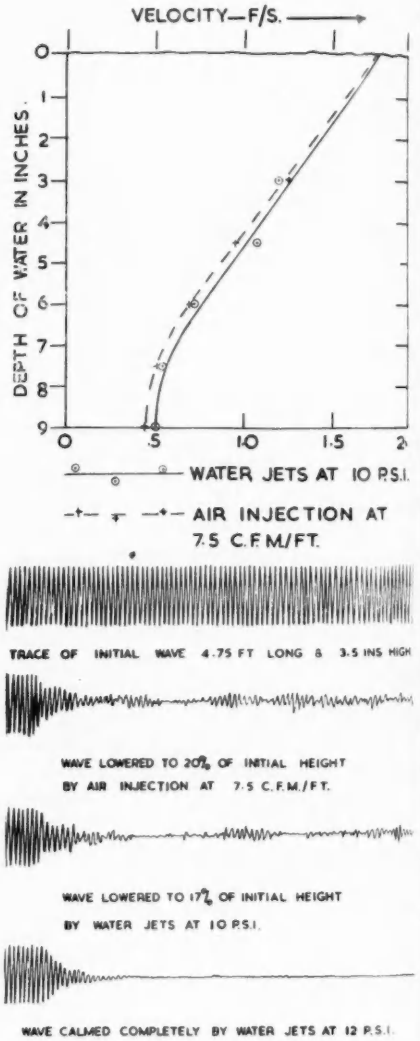


Fig. 2 (top right). Velocity Profiles of water-jet and air induced currents.

TRACE OF INITIAL WAVE 4.75 FT LONG & 3.5 INS HIGH
WAVE LOWERED TO 20% OF INTIAL HEIGHT BY AIR INJECTION AT 7.5 C.F.M./F.T.
WAVE LOWERED TO 17% OF INITIAL HEIGHT BY WATER JETS AT 10 P.S.I.
WAVE CALMED COMPLETELY BY WATER JETS AT 12 P.S.I.

Fig. 3 (lower right). Examples of wave lowering by water-jet and air induced surface currents.

Wave lengths were measured in the following way: at one end of its forward travel the wave-making paddle closed an electric contact causing the simultaneous lighting of two small lamps which could be clipped at any point on the side of the tank. One of the

Pneumatic and Similar Breakwaters—continued

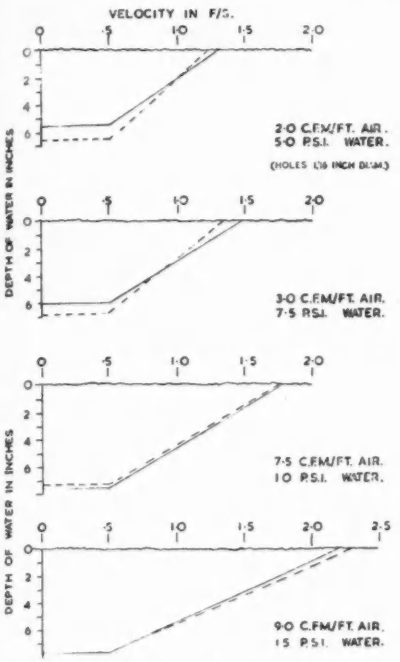


Fig. 4. Equivalence of water-jet induced currents and air induced currents in wave stopping power. In each pair of currents the full line refers to a water induced current, and the broken line to an air induced current of equal wave stopping power.

pair of lamps was adjusted until it flashed just as a wave crest passed a few inches beneath it. When the light was correctly adjusted its reflection from the water surface on the wave crest appeared immediately below it as seen from above. The second lamp was similarly adjusted further down the tank so that it too flashed just as a wave crest passed beneath it. The distance between the two lamps was then an integral number of wave lengths. It was found that each lamp could be adjusted consistently to within 2-in. giving a probable error in distance between the lamps of about 3-in. or about 2 per cent. in estimation of the longer wave lengths examined.

Current Velocities were measured with a standard river current meter of the vertical axis cup type.

Summary of Observations

General Survey.

It was found possible to lower the heights of waves with air injection and with water jets and both these methods have been studied over the range of wave lengths and height available. Completely calm water could be produced on the protected side of the breakwater when using water jets. With air injection however there was always some residual disturbance of the water surface on the protected side of the breakwater.

The horizontal surface currents of water set up by air injection and by water jets were measured and compared. In each case there was a high surface velocity declining sharply and linearly in a shallow depth as shown in Fig. 2.

Each velocity profile set up by the injection of varied amounts of air could be matched by a corresponding velocity profile set up by water jets suitably adjusted. It was found that these corresponding surface currents had almost the same wave damping effect whether the currents were set up by air or by water jets, as shown in Fig. 3. This equivalence between air-induced currents and water jet-induced currents was found over the whole range of air discharges available, as shown in Figs. 2 and 4.

From this it was concluded that the effect of air bubbles in calming waves is almost entirely due to the horizontal surface currents set up and that the bubbles as such have at most a very small effect on the wave motion; their function being that of an air lift pump entraining vertical currents of water which flow horizontally on reaching the surface.

From this point onward water jets only were used in the experiments because with the equipment available more power could be applied with jets than with air. To yield matched velocity profiles and equal stopping power the horsepower contained in the compressed air issuing from the perforated pipe was about three-quarters of the horsepower contained in the moving water the leaving the nozzles. The power exerted by the compressor motor however was roughly equal to that exerted by the pump motor

Quantitative Results.

It was found experimentally that the velocity of a surface current required to stop waves depends on the length of the waves, on their height, on the depth of water and on the thickness of the current.

With waves up to 6-ft. in length, that is twice the depth of the water in the tank, the mean velocity in the opposing surface current necessary for complete damping was found to be proportional to the square root of the wavelength. This relation agrees in form with that predicted by Sir Geoffrey Taylor's analysis[5] though the rate of proportion is found to vary with the height of the waves: as shown in Table 1 and in Figs. 5 and 6.

The horsepower required to stop the waves increases at a rate approximately proportional to the 2.5 power of the wavelength but again the rate of proportion varies with the height.

The horsepower contained in the opposing currents depends on their velocity profiles. The surface currents of thickness $L/10$ used in the tank had such velocity profiles as to represent a horsepower approximately 1.3 times the horsepower of currents $L/10$ thick but with uniform velocities equal to the mean of the velocity profiles. On this approximation the horsepower in the flowing water in the current $L/10$ is $2.3 \times 10^{-4} V^3 L$.

The horsepowers required to stop waves in deep water by a current of thickness $L/10$ are shown in Table 2.

Shallow Water.

When the waves are longer than twice the depth of water a faster velocity in the opposing current, and more horsepower, must be

TABLE I

Stopping Velocity of horizontal surface current L/10 thick, in deep water.	
Height / Length Ratio	Stopping Velocity, f/s. (Mean velocity in cross section of the current at the position of maximum velocity reached in its course)
0.01	$V = 0.50\ L^{\frac{1}{2}}$
0.03	$V = 0.62\ L^{\frac{1}{2}}$
0.05	$V = 0.73\ L^{\frac{1}{2}}$
0.07	$V = 0.83\ L^{\frac{1}{2}}$

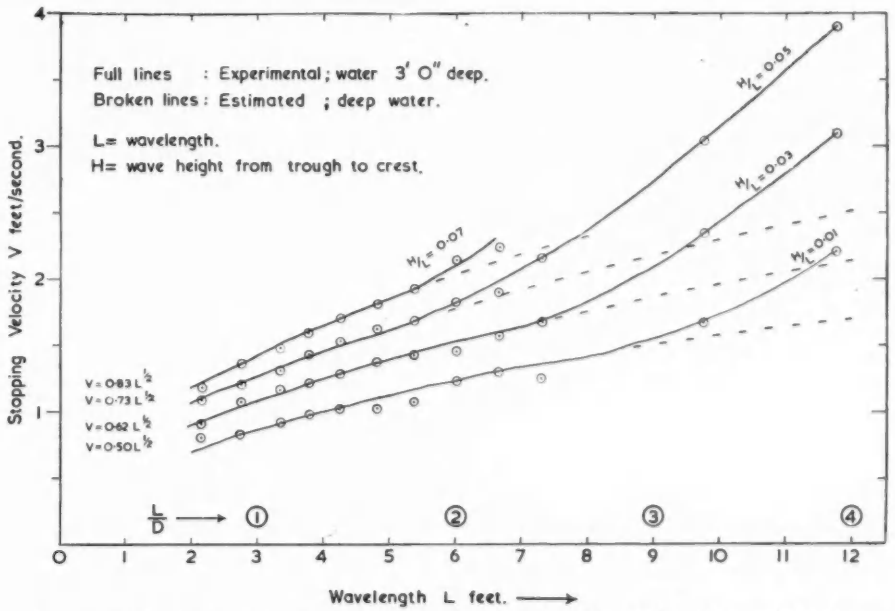


Fig. 5. Relation between Wavelength and Stopping Velocity of a Surface Current L/10 deep.

Pneumatic and Similar Breakwaters—continued

TABLE 2

Horsepower per foot run of wave crest required to stop waves of length L in deep water	
Height / Length Ratio	Horsepower contained in opposing current of thickness L/10, to calm waves completely.
0.01	$0.29\ L^{2.5} \times 10^{-4}$
0.03	$0.55\ L^{2.5} \times 10^{-4}$
0.05	$0.90\ L^{2.5} \times 10^{-4}$
0.07	$1.31\ L^{2.5} \times 10^{-4}$
The applied horsepower is expected to be about seven times these quantities.	

TABLE 3

Length / Depth Ratio	Factor giving stopping horsepower in shallow water. Surface current L/10 thick.		
	H/L 0.01	0.03	0.05
2 or less	1.0	1.0	1.0
2.5	1.0	1.1	1.3
3.0	1.2	1.6	2.1
3.5	1.6	2.3	3.0
4.0	2.4	3.4	4.0

used to stop them. The additional horsepowers required have been found approximately as shown in Table 3.

There is some indication that the wave stopping power of a surface current of thickness L/24 is affected adversely by shallow water less than that of a current of thickness L/10.

Partial Damping.

Waves may be lowered partially but temporarily by a following current as described. The amount of the lowering may be calculated by an extension of the analysis given. The lowering is confined to the area in which the following current flows: when the waves pass beyond the extent of the following current they resume their former height.

An opposing current on the other hand can lower waves partially in such a way that they will not resume their former height. The horsepowers required to lower the waves partially and permanently have been ascertained approximately by experiment: as shown in Table 4.

These percentages are approximately true for waves in deep water. Where the wavelength is more than twice the depth of water the effect of varying height of wave is less marked and the percentages for partial damping approximate to those given for H/L=0.03 for waves up to H/L=0.05. No waves of H/L=0.07 could be made in the tank with length more than twice the depth of water.

Comparison with Wave Horsepower.

The relation between the horsepower in the opposing current and the amount of wave

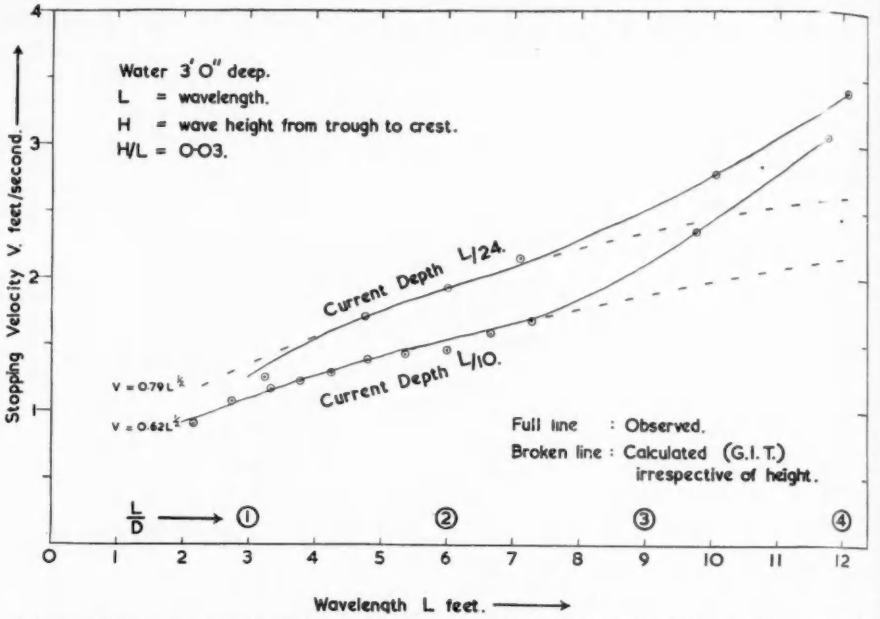


Fig. 6. Relation between Wavelength and Stopping Velocity of Surface Currents L/10 and L/24 deep.

horsepower dissipated depends on the height of the wave and on the degree of wave lowering achieved.

With waves lower than about H/L=0.04 the reduction in wave horespower is less than the current horsepower whether the wave is stopped or partially damped. With waves higher than H/L=0.04 the reduction in wave horsepower is less than the current horsepower for complete stopping, but more than the current horsepower for partial damping.

It is thus only in the partial stopping of the steeper waves that the reduction in wave horsepower exceeds the horsepower in the opposing current.

These relations are set out more precisely in Table 5.

In the cases under the double horizontal lines more wave horsepower is dissipated

TABLE 4

	Horsepowers required to lower waves to heights shown, expressed as percentages of horsepowers required to stop the waves completely. Surface current L/10 thick.			
Height / Length Ratio	Residual height of wave as fraction of initial height.			
	0	1/4	1/2	3/4
	Residual wave energy as fraction of initial energy.			
	0	1/16	1/4	9/16
0.01	100	86	72	37
0.03	100	64	44	20
0.05	100	48	30	13
0.07	100	42	23	10

than is contained in the opposing surface current.

The applied horsepower necessary to produce the opposing surface current is expected to be about seven times the horsepower in the current. In no case examined therefore is the applied horsepower less than the reduction in wave horsepower.

Currents of Differing Thicknesses.

The velocity of an opposing surface current required to stop waves depends on its thickness as shown in Table 6 and in Fig. 6.

These relations are derived from the analysis of Sir Geoffrey Taylor. The stopping velocities have been confirmed by experiment in the tank for current thicknesses approximating to one tenth and to one twenty-fourth of the wavelength but they are found to vary with the height of the wave. The calculated stopping velocities are irrespective of the wave heights.

The stopping surface current making the most efficient use of the power of its moving water is about one twentieth of the wavelength thick. The power contained in this surface current is 20 per cent. less than in the stopping surface of depth L/10 and 12 per cent. less than in the L/24 current (see Fig. 6).

Mechanism of Wave Stopping.

The effect of the horizontal surface currents appears to be to shorten and to raise the waves until they become too high for their length and they break.

The effect may be shown analytically as follows:—

The velocity of waves moving on the surface of still deep water is proportional to the square root of their wavelength:

$$V_1 = L_1^{\frac{1}{2}} \left(\frac{g}{2\pi}\right)^{\frac{1}{2}}$$

If the waves run into an opposing deep current of velocity V_c the wave velocity re-

Pneumatic and Similar Breakwaters—continued

lative to the moving water in the current becomes

$$V_2 = L_{\frac{1}{2}}{}^{\frac{1}{2}}\left(\frac{g}{2\pi}\right)^{\frac{1}{2}}$$

where $L/2$ is a new wavelength appropriate to the wave velocity relative to the current. The new wave velocity relative to the ground is $V_2 = V_r - V_c$.

The period of the waves, observed from the ground, remains unchanged as they pass into the current:

$$T = \frac{L_1}{V_1} = \frac{L_2}{V_2} = \frac{L_{\frac{1}{2}}}{V_r - V_c} \quad L_{\frac{1}{2}} = L_1\frac{V_r - V_c}{V_1}, \ldots . (1)$$

that is, the waves in the opposing current are shorter than those in the still water.

The rate of transmission of wave energy in deep water is proportional to $H^2\frac{V}{2}$ where H is the height of the wave from trough to crest and V is the wave velocity. Unless energy is reflected, dissipated or accumulated at the edge of the current the rate of transmission of wave energy, relative to the ground must be the same in the still water and in the current:

$$H_1{}^2\frac{V_1}{2} = H_2{}^2\frac{V_2}{2}, \text{ whence } H_2 = H_1\left(\frac{\frac{1}{2}V^1}{\frac{1}{2}V_r - V_c}\right)^{\frac{1}{2}}$$

that is, the waves in the opposing current are higher than those in the still water.

If the waves are sufficiently shortened and raised they become too steep for stability and they break.

It may be shown from (1) that

$$\frac{V_r}{V_1} = \frac{1}{2} \pm \sqrt{\frac{1}{4} - \frac{V_c}{V_1}}.$$

When $\frac{V_c}{V_1}$ reaches $\frac{1}{4}$, $V_r = 2V_c$ and $\frac{V_r}{2}$ (the velocity of travel of the wave energy relative to the moving water in the current) becomes V_c, equal but opposite to the current velocity. There is then no movement of wave energy relative to the ground.

Waves may therefore be stopped by a sufficiently thick opposing surface current flowing at only a quarter of their velocity. Experiment shows however that before the normal breaking steepness is reached partial breaking occurs such as is seen when waves roll over a submerged reef.

The effect on waves of a thin opposing surface current has been discussed mathematically by Sir Geoffrey Taylor[5, 12].

When the opposing surface current is a thin one of perhaps one eighth of the wavelength thick the contraction in wavelength takes place only in this top layer of moving water. The wavelength of the undulating water below the surface current remains as before.

Turbulence and eddies occur at the horizontal interface between the current and the still water and energy is lost without need for the wave to be raised to breaking steepness. With thin opposing surface currents therefore some damping may take place without breaking. This has been confirmed by the experiments in the tank.

Waves in a following current, conversely, are lengthened and lowered. On the protected side of the pneumatic breakwater there is a narrow area in which the current and the waves move in the same direction. Waves are lowered while passing through this area and raised again a short distance beyond the reach of the current. The amount of the lowering may be calculated by an extension of the above analysis. The lowering is small compared with that due to the opposing current on the seaward side of the breakwater.

TABLE 5

Height / Length Ratio	Reduction in wave horsepower, expressed as percentage of the horsepower in the opposing current. Surface current L/10 thick. Deep water. Residual height of wave as fraction of initial height. 0	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$
0.01	5	6	6	6
0.03	26	37	44	57
0.05	46	87	114	153
0.07	62	139	193	273

TABLE 6

Thickness of surface current as percentage, and as fraction of wavelength.		Stopping Velocity as percentage of Wave Velocity $V = (5.13L)^{\frac{1}{2}}$	Relative Values of stopping horsepowers in surface currents.
2.5	L/40	45.5	172
4.2	L/24	34.5	113
5.0	L/20	31.0	100
10.0	L/10	26.5	126
14.0 or thicker	L/7	25.0	152

TABLE 7

Wave Length Feet	Wave Height Feet	Horsepower per foot run of wave crest required in the opposing current to produce the following effects. Residual height of wave as percentage of initial height: 0	25%	50%	75%
		Residual energy of wave as percentage of initial energy: 0	6%	25%	56%
100	1	3.0	2.6	2.2	1.1
	5	9.0	4.3	2.7	1.2
150	1.5	8.0	7.0	5.8	3.0
	7.5	25.0	12.0	7.5	3.3
	10.5	37.0	16.0	8.5	3.7
200	6	31.0	20.0	14	6.1
	10	51.0	25.0	15	6.6

Application to Dover.

At Dover the dock gate was 75-ft. from the pneumatic breakwater and the current on the protected side extended from the breakwater almost to the gate. In this area there would be a lowering of the waves due to this following current in addition to any lowering resulting from the current on the seaward side. There may also have been a small pressure on the gate due to the velocity of the water in the current on the protected side.

The channel was 80-ft. wide and the depth of water between 40- and 50-ft. The waves were reported to be from 120 to 150-ft. long and about 4-ft. high. The air compressor used gave from 120 to 150 h.p. The resulting surface current was reported to be about 1-ft. 6-in. deep and its velocity 4½-ft. per second.

Applying the experimental results to the conditions at Dover it is estimated that both currents together would reduce the wave energy by about 10 or 12 per cent. Even such a small fall in the energy opposing the gate motion might have made the difference between success and failure.

Length of Marine Waves.

Storm waves longer than 250-ft. seldom occur round the coasts of the British Isles except at those parts exposed to Atlantic gales.

The Admiralty Navigation Manual describes the common run of waves in the Atlantic as being from 160-ft. to 320-ft. long with occasional waves of 500-ft. to 600-ft.

Inquiries recently made at ports round the British coasts have produced few reports of waves more than 250-ft. long and not many of 200-ft.

The protective works at the temporary military harbours in Normandy in 1944 are reported to have been designed to withstand waves of 150-ft. in length but in the great storm of June 19th/23rd waves of 300-ft occurred[10].

Approximate Intimations of Full Scale Effects

The full scale relation between wave motion and opposing surface current is not expected to differ greatly from the relation found in the wave tank. On the other hand not enough is known about the efficiency of generating surface currents at full scale, whether by air bubbles or otherwise, to justify more than approximate estimates of the horsepowers necessary to produce any given currents.

Table 7 sets out the horsepowers required in the opposing surface currents to stop waves or to lower them. The depth of water has been taken as at least half the wavelength and the thickness of the surface current has been taken as one tenth of the wavelength. (Corrections for shal- current are given in Table 6.)

The horsepowers given above are those contained in the water flowing in the currents. From what information is available about full scale effects it is reasonable to estimate that surface currents may be generated at an efficiency of about 15 per cent.

Pneumatic and Similar Breakwaters—continued

To obtain the horsepowers necessary to drive the pumps or compressors therefore the figures shown in the table should be multiplied by seven.

Conclusions

The results of the investigation may be set out as follows.

(a) The mechanism of the method has been experimentally established by equating numerically the velocity profiles and the wave stopping power of horizontal surface currents induced by air injection and otherwise.

(b) The observations have been related to a mathematical analysis applicable to shallow surface currents, the only way of using the method in practical applications.

(c) Methods have been derived for calculating the velocity, depth and horsepower of the opposing surface currents required to stop waves given their length, height and the depth of water, or to lower them by any desired amount.

(d) The experiments have not been on a large scale: the longest waves damped being 11.75-ft. long. The horsepowers quoted in Table 7 should therefore be regarded as approximate.

(e) For complete calming the horsepowers rise steeply with longer and higher waves. For partial damping substantially less power is required.

(f) Whether the larger horsepowers per foot run of wave crest can be effectively applied in practice to the generation of surface currents by water jets or air injection or by other means has yet to be determined.

A few experiments on this point would be of value. They could be done in still water with comparatively little discharge of air in a narrow but deep water passage such as a caisson camber.

(g) Present indications are that the complete calming of waves of 200-ft. and more in length is unlikely to be economic and may be impracticable. Partial damping of these waves may prove practicable and in some cases economic.

REFERENCES

1 Compressed Air Magazine: January, 1921.
2 Admiralty Experiment Works: 17/1925; June, 1925.
3 Bulletin of the Permanent International Association of Navigation Congresses: January, 1937.
4 Unpublished private report, 1936.
5 Admiralty Report: ATR/MISC, 1259, 1943.
6 Admiralty Report: ATR/MISC, 1685, 1943.
7 Nature: 21st February, 1942.
8 California Institute of Technology: Hydrodynamics Laboratory Report No. N-64.2., 1950.
9 The Dock and Harbour Authority, December, 1952.
10 The Civil Engineer in War, Vol. 2. Institution of Civil Engineers, 1948.
11 Proc. Roy. Soc. A. 231, 457. 1955.
12 Proc. Roy. Soc. A. 231, 466. 1955.

The Working of the London Docks

Report of the London Chamber of Commerce

For some considerable time there has been much concern about delays occasioned to goods passing through the Port of London. In June, 1955, the London Chamber of Commerce issued an interim report on the subject and in September last held a conference for the purpose of obtaining the views on the interim report of all the main interests concerned, with London's import and export trade. The organisations represented at the conference were:

Association of Master Lightermen and Barge Owners.
British Transport Commission.
British Waterways (Regents Canal Dock).
Federation of London Public Wharfingers Ltd.
Import and Export Merchants' Section of the London Chamber.
Institute of Shipping and Forwarding Agents (London and District Branch).
London Association of Public Wharfingers Ltd.
London General Export Merchants' Group.
London General Shipowners' Society.
London Short Sea Traders' Association.
National Conference of Road Transport Clearing Houses.
Port of London Authority.
Road Haulage Association (Metropolitan and South Eastern Area).

The first point made in the "Final Report" which was published as a result of that conference, was that the opinion is held that the causes of the delays fall under two headings. viz.: labour difficulties and operational problems. Under the first heading it stated:

"That the users of the Port are suffering from strong feelings of frustration and indignation there can be no doubt at all. Twice within six months severe losses were inflicted on exporters who had paid for goods which they could not ship and for which, therefore, they could not obtain payment from their overseas buyers, and upon importers who had bought and paid for goods which they could not deliver to their customers and so again were out of their money. Moreover, exporters were forced to sit idly by and see business connections, which they had built up overseas at great expense, lost to foreign competitors, as confidence in the ability of this country to carry out its engagements was undermined. The users of the Port were not parties to the disputes in the dock industry, whether these were between employers and workpeople or between two rival Unions, but undoubtedly the major losses resulting from these disputes fell upon them and it appears that they have no remedy at law against anyone. It is submitted that this is a quite intolerable state of affairs and that in any ordered society it should not be possible for individuals or groups of individuals to inflict loss and suffering on other groups of citizens without some redress being available.

Fear and Suspicion.

"The Chamber feels there is reluctance on the part of the men to co-operate with the employers in the introduction of improved methods of working designed to speed up the handling of goods and to improve the turn-round of ships, because at the back of their minds there is the fear of unemployment and a reversion to the evils of casual labour which prevailed prior to the war.

"The Chamber therefore urges that the port employers should make the strongest possible efforts to convince the men and their Unions that they have no intention of seeking to revert to pre-war conditions in the docks. It should also be brought home to the men that they and their families, in common with the rest of the community, will suffer in the long run from the loss of exports and immediately from increased prices consequent upon delays in the movement of goods through the Port. If the goodwill of the men could be secured this Chamber believes that most of the troubles in the Port would be resolved and that consequently every method of obtaining this desired end should be thoroughly examined. In this connection, the Chamber also urges that the proposals whereby new entrants into the Dock Labour Scheme could be trained to become responsible dock workers should be pursued with the energy they deserve.

Overtime.

"A ban on overtime operated in the Port of London throughout most of 1954 causing severe damage to the trade of the Port.

"The cost of the National Dock Labour Scheme is borne directly or indirectly by the users of the Port and in return they feel themselves entitled to receive an efficient and regular service. There are many industries which, from their nature, necessitate work outside the normal working hours of the day, and when entering those industries workers are well aware of these conditions. For example, gas, electricity, newspapers, transport, the delivery of milk in the morning and of market supplies of fish and vegetables, all necessitate work outside the normal working hours. The operation of the docks has always been recognised as being within this category owing to tides and the vagaries of weather. The Chamber has no desire to see men working abnormal hours at a stretch at hard manual labour; in fact it does not believe that this is the way to obtain the efficient service to which users of the Port are entitled. It is, however, convinced that it should not prove beyond the wit of man, with goodwill on both sides, to ensure that when work is necessary outside the normal hours the men, whose services were not required at the morning call, should be made available for the purpose. This would assist the quick turn-round

The Working of the London Docks—continued

of ships and ensure that lorries are not kept waiting to be unloaded for many consecutive days as has occurred in the recent past.

Mechanisation.

" Although certain operations in the Port of London are fully mechanised, the Chamber understands that generally mechanisation has been introduced only to a very limited extent, the reason being that the men are reluctant to operate fork-lift trucks and other similar equipment if allied to a reduced manning scale. To mechanise dock operations completely would cost a very considerable sum of money and unless port employers can be sure that they will get a return on that money, it would clearly be uneconomic for them to instal such costly equipment. In other words, if by the introduction of mechanisation, employers have to pay out the same amount of money in wages as they did when the work was done manually, the employers would have spent their capital to no good purpose and the cost of handling the goods would thus increase. But if the men would accept reduced manning scales, the cost of handling would be comparable to manual effort and the speed of handling would be much greater. The Chamber understands that, in spite of the cost of such equipment, port employers are anxious to develop mechanisation but unless it can be introduced on an organised basis, progress in this direction cannot be made.

" In view of the foregoing, the Chamber urges that every effort should be made to acquaint the men of the obvious fact that by accepting mechanisation allied to the necessary reduced manning scales, they will be able to carry out their work with far less manual effort in a much quicker time. It should also be pointed out to them that the acceptance of mechanisation would not mean the dismissal of any worker in the dock labour force for the reason that natural wastage, i.e. the number of men who for one reason or another leave the industry annually, would quickly absorb any surplus caused by the reduction in the number of men per gang. It would also increase the efficiency of the Port, attract more traffic and in the long run increase the prosperity of the dock worker.

" Users of the Port have to compete with their rivals in other ports on the Continent and elsewhere, but cannot do so unless dock workers fully co-operate in the modernisation of the Port. Again, they believe that with proper organisation and goodwill between employers and workpeople obstruction, where this exists, could and should be removed."

The second heading, " Operational Problems," is divided into several sections. Under the sub-heading " Control of Goods Arriving at the Docks," the report states:

" Having been notified of the dates on which a ship will load, shippers send down their goods by road and rail on these dates. When the vessel arrives late at the berth and is therefore not ready to load on the notified dates, congestion of goods and vehicles often results. The goods are placed in the shed until the ship is ready. As the shed can only accommodate part of the cargo intended for that vessel, when once the shed has been filled no more vehicles can be unloaded until some goods have been transferred to the ship thereby making more room in the shed. This means that vehicles are turned away thus causing unnecessary expense to the shipper and to the haulier.

" The Chamber realises that nobody is in favour of reintroducing registration or permit systems—least of all shippers. It does, however, seem to the Chamber that congestion at the docks will occur from time to time unless some system can be devised to hold back the despatch of goods to the docks when congestion is threatened. It would welcome investigation of this matter by the three bodies primarily concerned, namely the Port of London Authority, the shipowners and the shippers. It might well be that some form of check system, possibly by the endorsement of shipping notes, could be introduced. This would authorise the delivery of goods to a ship and provide a means of slowing down the flow of goods when necessary."

The need for staggered-to-ports loading dates is also stressed and in this connection the Chamber calls for the co-operation of shippers to spread their deliveries evenly over the whole of a ship's receiving period.

" It is known," it states, " that many shippers delay their deliveries to the docks until the last day or two of a ship's receiving period in the mistaken belief that the last goods received will be the first to be discharged at destination. This is an erroneous assumption and to act upon it causes delays and congestion, even shut-outs, and the Chamber feels that the widest publicity should be given to the harm caused by this practice.

" The loading of a ship is not governed by the order in which the goods arrive at the berth but by such considerations as trim of the ship, seqence of ports of call, space to be left for loading en route and the weight, shape, nature and packing of the various consignments. Such factors govern the stowing of cargo in ships' holds and the sequence of arrival of the goods is not necessarily reflected in the resulting stowage plan.

" In the Chamber's opinion delays and congestion could be reduced if traders generally were to receive and deliver goods on Saturday mornings. The situation to-day is that while the operators of the port and the transport industry work five and a half days a week and sometimes on a Sunday, the majority of traders close their premises on Saturday morning. If traders would arrange for the reception and despatch of goods on Saturday mornings this would undoubtedly ease congestion."

The Chamber considered, too, the question of the expansion of the London Docks system. " The docks of London," the report states, " are situated in densely built-up areas and it is very difficult to obtain land in the vicinity for development. In particular the Chamber understands that land that has been acquired by the Port Authority to the north of the Royal Albert Dock for future dock extensions has been zoned by the local authority, under the Town and Country Planning Acts, for other purposes, e.g. playing fields.

" In the opinion of the Chamber it is essential in the national interest that provision should be made for future dock extensions in order that the Port of London may be equipped to deal with developments of shipping and expansions of trade so that London may retain its pre-eminent position among the ports of the world. The Chamber recommends that the attention of the Government be drawn to this vital matter."

That there have been expensive delays in the work at the London Docks is not in dispute. The job the conference had to tackle was to establish the causes of these delays and then to seek remedies.

There is no doubt that the Port of London Authority has done its utmost to provide the maximum facilities in existing docks and it is much to the point that the expansion of its Royal Docks system is under serious consideration. In existing conditions, however, a large part of the task of alleviating congestion and delays lies with the users. Two urgent needs are better co-ordination between the parties despatching, conveying, receiving and shipping exports and better co-operation from labour. As emphasised in the report, if the flow of goods to the docks were regulated properly, many of the present difficulties would disappear.

The report does not mention the fear that some shipping companies have that if they introduce a satisfactory control and their competitors do not, they will lose a part of their business. This is a real factor and there have been cases where a shipping company wishing to co-operate, had had to abandon its schemes because shippers did not wish to be bound by a new and sensible co-ordinating arrangement.

In the sphere of labour, the report rightly urges more co-operation and a more realistic approach by the men, particularly to mechanisation and to working overtime, which is surely a need inherent in the industry. It also deplores the serious unofficial stoppages which occur only too frequently and it is therefore an interesting fact that the National Dock Labour Board, the body responsible for disciplining men who break the terms of their employment, was not present at a conference which was so much concerned with dock labour difficulties. This is not, of course, a criticism of the Board, it is a pertinent comment upon the present labour set-up in Britain.

This once more brings to notice the point of view now being not only accepted but pressed by many interests in the port industry in this country, namely, that until the present scheme is amended so that men who act irresponsibly and disorganise the work can be brought to task, the co-operation of labour will be extremely difficult to gain.

The Rapid Turn Round of Ships

Effects of Loading Operations on the Speed and Cost of Discharge

By E. S. TOOTH

STEVEDORING agents frequently voice a firm conviction that ship discharge could often be done much more quickly if greater attention were paid to their requirements at time of loading. There is no doubt that the manner in which cargo is stowed in ships' holds is an important factor in the speed of unloading, but also of importance at the time of discharge is the availability of a satisfactory stowage plan and of pertinent information concerning hold construction and the condition of cargo.

These requirements may seem elementary but they are not always satisfied. Dock labourers are not the only body of men whose attitude to work has in many cases changed since pre-war days; many ships' officers, British and foreign, now have a different interpretation of their duties. In the 1930's it was the practice for such officers, under the supervision of their Chief Officer, to take a keen interest in and, indeed, to exercise a certain control over loading and discharging operations. In many shipping lines this excellent practice still obtains but in others there is more than a tendency for the officers to believe that the extent of their job is to take their ship from port to port, leaving loading and discharging almost completely in the control of the shipping company's various agents.

Where this attitude exists, it is, of course, mainly the result of war conditions. Whilst at sea during 1939/1945, ships' officers had a full-time nerve-racking job looking after the safety of their vessels and were obviously entitled to leave whilst their ships were in port. Moreover, as the war developed, ships began to carry lease-lend goods and governments embarked upon a policy of bulk buying; thus there was no longer the need for the meticulous and careful stowing and separation of large numbers of small consignments, for discharge at several ports. It is only in recent years, in fact, that there has been a large-scale reversion to peacetime trading practices and consequently there is a big gap in experience which it is being found difficult to fill. Many shipping companies are meeting this situation by giving more responsibility to their shore superintendents but just how the general responsibilities once assumed by the Chief Officer should now be divided between that officer and the shore superintendent, particularly in the matter of allocating stowages, is indeed a controversial question. However, be that as it may, the fact remains that where, for whatever reason, there is lack of co-ordination of loading and discharging requirements, ship turn-round suffers accordingly.

The need for special attention at loading is probably greatest with general cargo vessels, with their deep tanks, alleyways, cupboards, stanchions, trimming hatches, propeller-shaft tunnels and other constructional details which make for awkward working. In this type of ship there are, in fact, plenty of stowages in which pieces and packages heavy and awkward to handle should never be placed except as a last resort. The term "awkward" covers a wide range of goods—for example, blocks of marble and granite, greenheart logs (which may be more than 70-ft. long), crates of veneers, heavy and cumbersome vehicles on wheels (e.g. double deck omnibuses), bulky packages of irregular shape (particularly if without battens), cases (of machinery, say) with their centres of gravity in unexpected places and even animals in cages.

Wherever heavy or bulky packages are stowed, they should if possible be dunnaged. Nothing is more irritating to the discharging stevedore than to find heavy packages flat on the ceiling or the deck of the ship and needing arduous prising (sometimes to the detriment of the goods) before they can be slung. Heavy bundles of steel plates have sometimes been stowed in this manner. To have lowered them on to dunnage would probably not have prolonged the loading operation, yet the absence of dunnage made slinging difficult and delayed discharge. With some goods—steel billets for example—the material itself can be used for dunnaging.

When particularly awkward or heavy pieces or packages are being handled, attempt is usually made to stow them where no pushing or pulling is required. In addition, loading stevedores will sometimes arrange for the shipping company to borrow or to purchase their lifting equipment, which then travels on the vessel to the port of discharge. An unusual package may even remain in the slings ready for lifting at destination but if neither of these courses is followed, the stevedore may warn the shipping company of the need for special slinging gear at unloading.

Another point in connection with the stowage of bulky packages is that care should be taken with "chocking-off." The selection of goods for this purpose is important, in respect of both the type of cargo used and also its destination. An instance occurred recently where small pieces of lumber used for chocking-off fell between big, awkward packages which were for discharge at a later port of call. To extract the lumber took a disproportionate time—indeed, it lost the ship a tide.

The question of attention at loading to assist discharge does not, of course, refer only to awkward and bulky goods. With most types of cargo there are simple practices which can usually be followed which are, indeed, very worth while. To amplify this statement, it will be useful to quote instances where the wrong method has been employed. The tanks in No. 3 hold of a certain vessel were filled with four bills of lading of the same commodity, all for discharge at the same port. The foreign loading agent stowed two consignments in the port tank and two in the starboard. Had each consignment been split between the two tanks, the discharging gang could have worked them simultaneously and thus obtained much higher outputs—and it cannot be over emphasised how important it is that a piecework gang shall have the opportunity of straightforward working.

Other instances were where slabs of marble 8-ft. long and 4-ft. wide were stowed on edge but not on dunnage and where barrels of molasses were badly affected by heat when stowed several tiers high adjacent to the ship's engine room. Their escaping contents damaged other cargo, causing further complications. Yet another example was the stowage of bales of crepe rubber on the ceiling of a ship, under several hundred tons of other cargo, which caused them to stick together in large masses, impossible to break up and very awkward and slow to handle. This does not happen when they are given top or 'tween deck stowage.

The stowage of goods in alleyways is always a matter for special care. These often run alongside the engine room, when they are 40-ft. to 50-ft. long. They connect Nos. 3 and 4 holds and have storm doors at each end. Two recent stowages had serious delaying effect upon discharge. In one case, cut lumber was stowed athwart the alleyway and flush with and overlapping No. 3 door, making discharge from this end of the alleyway impossible. Thus all cargo had to be carried out of No. 4 door, and the further the gang worked inwards, the slower and more awkward the job became. The other case concerned dunnaging. The placing of pieces of 20-ft. dunnage *along* the alleyways prevented any wheeled equipment approaching the piles. Had short dunnage been put down *across* the alleyways, much arduous man-handling in a confined, warm space could have been avoided.

It should be mentioned here how important it is that loading agents and ships' officers should know the conditions obtaining at the ports of discharge of their cargo. Cargo in the tanks of No. 3 hold can again be quoted as an example. In one vessel recently, because of contamination risk, it was necessary to stow two big consignments, A and B, one in each tank, although both were for discharge in London. Had there been knowledge on board at loading that (1) commodity A is invariably delivered to barge and commodity B to quay shed, and (2) the vessels concerned

Rapid Turn Round of Ships—continued

always berth the same way round, the correct tanks would have been chosen. Parcel B could then have been put ashore by crane whilst parcel A was being delivered to barge by ship's derrick. Unfortunately, the cargo was reversed and, without swinging the ship (which was not convenient) only one gang could work at a time. Such a question would not have arisen at, say, Hamburg or Liverpool; at a port where a big proportion of cargo is taken away by water it is a pertinent one.

Another simple and probably very annoying example was where bulk cargo was loaded into Nos. 1 and 5 holds for discharging at a United States port where the shore facilities, grabs to fixed hoppers, existed to serve only the holds amidships—viz. Nos. 2, 3 and 4. A final instance is where a heavy lift, which it was well known would be for discharge by floating crane, was placed on the port instead of the starboard deck of a vessel when the Chief Officer omitted to take into account that the ship is always moored at the port of discharge with her port side against the quay.

Although loading stevedores cannot be expected to take steps to place packages in stowage with their marks on view, there is often much scope for improvement in the sphere of marks and marking. Where ships are being loaded with cargo for more than one port, crayon or paint colour-marking can be used with much benefit, either in the transit shed before loading or in the holds as each consignment is stowed. The question of the marking of goods by manufacturers is also important to the stevedore who has to unload mixed parcels. The clearer and bigger the mark the better, obviously, but it is often also important *where* the mark appears on the package. Bales of plywood shipped to Great Britain from Japan are an example here. They are tendered to the ship in very small lots and consequently there is no opportunity to stow each mark separately. In the hold they are piled on the flat and, although stowing is good, there is often considerable delay in discharge because, since there is no marking on their edges, many packages have to be turned over to establish to which bill of lading parcel they belong.

Cases of apples and pears from Australia and cartons of canned goods from South Africa are other examples where consignments are frequently loaded into the ship mixed. With the former traffic, steps have already been taken by the National Federation of Fruit and Potato Traders Ltd., to simplify the marking with a view to avoiding delay at discharge and delivery. The method adopted is for all cases to bear the shipping number allocated by the Federation or by the Australian Apple and Pear Board. These numbers are printed in marks not less than $1\frac{1}{4}$-in. high, where practicable on both ends of the cases. They are the only marks recognised by the shipping companies and no other marks are shown on the bill of lading.

Similar steps are being considered with the South African canned goods traffic. The suggestion is to simplify the marking by using a code and to have the mark printed on both ends of every carton in letters not less than $1\frac{1}{2}$-in. high.

However, although in many traffics all over the world mixing of marks is very difficult to avoid, it is not always a final answer to this question to say that goods are tendered to the vessel either in very small lots or already badly mixed. It is sometimes possible for shipping companies to take steps which will reduce or even obviate mixing in the vehicles and craft bringing the goods to the vessel. There is no doubt that, where separate stowages *can* be made in the ship, a number of interests benefit considerably. If sorting has to be done on board, it costs the ship time and money; if done in transit shed, it still costs time and money but it can also mean that the goods suffer at least one extra handling. Landing, for sorting, goods which were destined for direct delivery from ship to craft also often creates congestion in the shed, thus causing delay to the discharge of the current and subsequent vessels. Casual and unnecessary mixing of marks wastes time, space, labour and money.

On the other side of the picture there are many instances to prove that co-ordination is well worth while both in turn-round time and in stevedoring costs. Cargo for last ports of call is usually placed to avoid restowing when other goods are required, although sometimes it has been found needlessly obstructing locker doors. Goods highly susceptible to damage, such as cornstarch, fine sugar and many commodities in paper bags, are normally given stowages in or near the square of the hatch. Such goods, of course, cannot in any circumstances be "dragged out" and should always receive the minimum number of handlings.

A simple example of co-ordination occurs in the cut lumber traffic from North America to Great Britain. The practice of certain shipping lines is to ensure that each parcel is loaded separately, properly marked off in ship's hold and given a special lot number. This number has no relation to the bill of lading number. It is allocated after loading, it is an indication of stowage and is shown, as well as the bill of lading number, on the cargo plan. Parcels in No. 1 lower hold are lot-numbered 1 up, those in No. 2 lower hold 21 up, in No. 3 lower hold 31 up, and so on. 'Tween deck parcels are given numbers in the hundreds range, top deck parcels in the thousands range. The most important effect of the method is that every interest in the port of discharge—shipping company's agent, master stevedore, ship's clerk, consignee and transport contractor—knows well in advance where any parcel is stowed in the ship. Although, as far as delivery to craft is concerned, it is, of course, the ship's clerk's duty to order barges, this particular method has proved very beneficial. If a lighterage contractor has to collect lots 21, 410, 510, 511 and 1006, for example, he knows immediately that (1) lot 1006 is on deck at No. 1 hatch and will probably rise on the first day of discharge, (2) lots 410, 510 and 511 are in the 'tween decks of Nos. 4 and 5 holds and might rise simultaneously in each hold (he may therefore require two barges for them) and (3) lot 21 is on the ceiling of No. 2 hold and may be the last parcel out of the ship.

Experience has shown that the fact that all interests usually have knowledge of stowage prior to the arrival of the vessel (the stowage plan comes by air) results in a saving of barge and vehicle time, it reduces congestion of craft around the ship and of lorries and railway wagons on the quay and it therefore gives the ship and quay piecework gangs increased incentive for speedier working.

In some trade routes attempts to get parcels of lumber tendered so that they can be stowed separately in the hold have been given up; in others there is the complication of duplicate marks. In certain instances, parcels are stowed separately but the separation is poor—frequently being made with thin string, an unsatisfactory method—and in such cases discharging agents have pressed for and sometimes obtained prominent paint-marked separations of bill of lading quantities.

Shipments of logs usually create difficulty for the discharging stevedore. The mixing in the holds of bills of lading parcels and of heavy logs with light ones is probably unavoidable. When, however, particulars of heavy logs are not available, there can be much delay changing barges and slinging equipment and also in alternating between one purchase and another. Heavy duty derricks and cranes, being slower working than standard capacity machines should not, in the interests of speed and econmy, be used for light logs. Progress has been made in this sphere, too, and the Chief Officer is now usually able to give the stevedore details of the numbers, weights and stowages of logs of, say, over 3 tons so that discharge can proceed without unnecessary delays.

Where more delay has been experienced for many years is in the identification of individual logs by the ship's tally clerks. Logs are discharged to mark and number, which are put on with scribing iron. For various reasons it frequently occurs that the exact point of marking cannot easily be detected and much time is lost searching for it. Recently, at the suggestion of discharging agents, arrangements have been made in isolated instances for the scribed mark and number to be painted over and in such cases they are prominent.

Most bulk materials will run into any recess in the hold construction and in some cases the small quantities involved will take a disproportionate time to work out. Parcels which are trimmed into under-deck stowage are also slow working, not being accessible to grab, electro-magnet, or any other direct-lifting appliance. Unhappy stowages of bulk are sometimes made thoughtlessly, for there is often much more suitable cargo available for the deep tanks, and after end of No. 2 'tween deck (which may have a "run-in" of 28-ft.) or the "coffin" between the propeller shaft tunnels

Rapid Turn Round of Ships—continued

of a twin-screw vessel. Obstructions, such as a pile of anchor chains or a spare propeller, overstowed by bulk material can easily delay discharge, not only because of the need to clear cargo from them but also because, if their presence in the bulk is not known to the stevedore, they can cause damage to trimming machines and sometimes to the grabs. The presence of these buried obstructions should be indicated on the stowage plan but this is seldom done.

Raw sugar is a commodity which has only recently been shipped in bulk. It has its own characteristics and the present methods of carrying and handling it are an example of how co-operation between various interests have eased the difficulties of discharge. In the first few years the commodity would often cake in the holds. When a whole cargo did so, a difficult problem arose at discharge. The grab would cut down into the bulk but the sugar would not "run." Indeed, it sometimes formed high cliffs which could not be successfully tackled by trimming machines and which added an element of danger to the arduous manual work of breaking them down. These unsatsifactory working conditions made discharging agents and shipping companies treat this problem as urgent and serious and as the result of research by the sugar refiners, accompanied by experiments by shipping companies and their stevedores, a solution was found. The Chief Officer now accepts the responsibility of ensuring that the minimum ventilation is given to the holds during the voyage and when this is done serious caking does not occur.

No universal solution has been found to the problem of handling speedily bulk scrap metal (another commodity with its own characteristics) and in this case there is no doubt whatever that a good stowage can reduce discharging time certainly by hours and sometimes by days. This commodity can seldom be trimmed mechanically and since manual trimming is both very slow and dirty, it always pays from the discharging point of view to stow it in the square of the hatch.

It might be mentioned that many of the difficulties described are unlikely to occur with palletised cargo. When not stowed under plumb of the purchase, palletised unit loads must be conveyed under deck by fork lift truck or pallet truck, in which case machines of the same type can easily bring them to the square of the hatch again in time of discharge. The question of dunnaging does not arise, neither does that of mixing marks. There is the point, of course, that the machine will be better able to work in some holds than in others, but since that also applies at loading, awkward stowages will only be resorted to when conditions demand them.

Enough has now been written to make it clear that there are many opportunities for action by shipping companies through their home and foreign agents, shore superintendents, loading stevedores and clerking organisations, which would result in the saving of time, space, money, labour and even temper at the time of discharge. It is appreciated, of course, that while it continues to be necessary to fill all available space, awkward stowages are bound to occur. It is also appreciated that the choice of goods for such stowages is governed by a number of factors, one important one being that ships often both load and discharge at several ports. Nevertheless it is certain that ways and means still exist of simplifying the work of discharge so that turn-round time may be saved, and damage to cargo, handling equipment and even the ship itself avoided.

The detrimental effect of mixing consignments has been discussed. It has been taken for granted that the proper separation of dirty goods, a classic example of which is carbon black, is a normal procedure; in fact, shipping companies can have little complaint on this score. Poor separations of ordinary goods do occur, however, and create problems of mixed cargo which need never have arisen. It is a fact, too, that poor separations and poor stowing at one port can affect the work at others and may even spoil the whole loading plan of the vessel.

There is no doubt that discharging agents would be pleased if the pre-war practice, whereby loading and discharging were done with the active co-operation of the chief officer and his colleagues, again became universal. In this connection it must be stressed how useful it can be for ships' officers and loading agents to have knowledge of conditions at discharging ports—crane capacities, rail facilities, transit accommodation, conditions of labour employment and so on. Instances have occurred where shipping companies have sent representatives to ports abroad to disseminate such knowledge and to ensure that discharging requirements are met at loading whenever possible. One of many such requirements is the preparation of a clear and accurate cargo stowage plan, without which discharge cannot be done efficiently.

Fig. 1 is a good example not only of a clear stowage plan but also of the separate stowing of bill of lading parcels, which is only possible when proper attention is given by those concerned with the loading of the vessel. This stowage plan is of No. 1 hold of a vessel bringing cargo from the Far East. Fig. 2 is a reconstructed stowage plan of a vessel carrying lease-lend cargo from the U.S. to Great Britain during the last war.

It is believed that shipping companies would reap a worth-while reward if they gave this whole matter considerably higher priority.

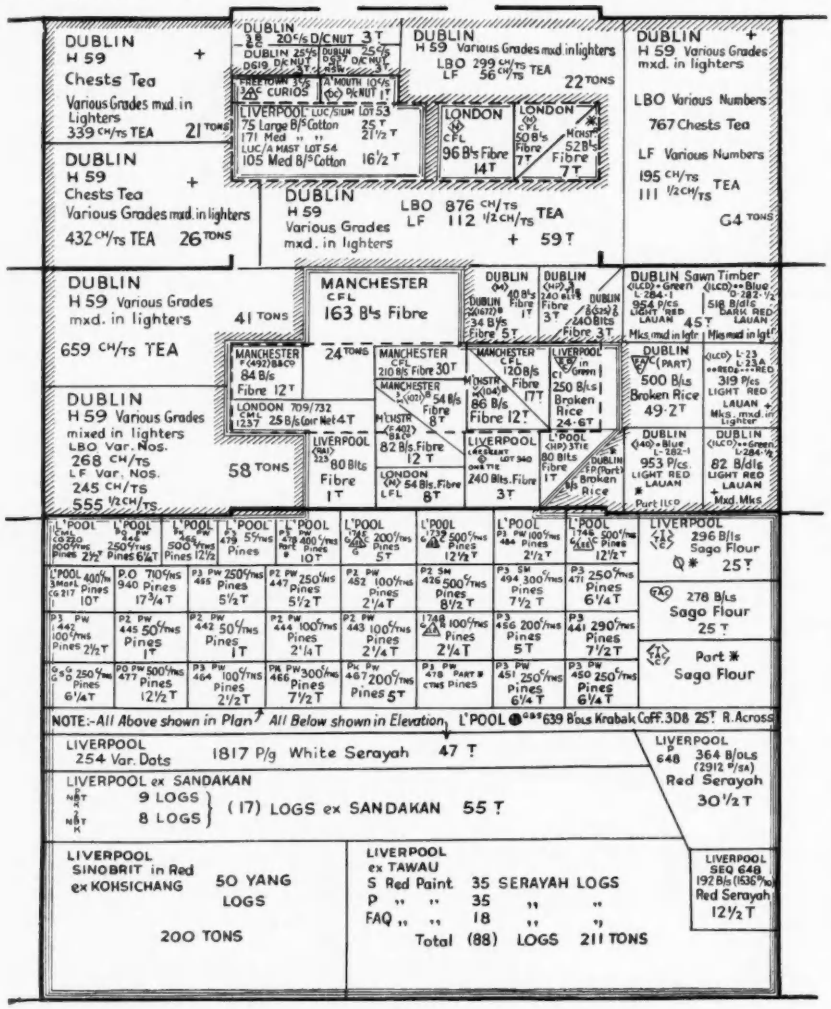

DUBLIN H 59 + Chests Tea Various Grades mxd. in Lighters 339 CH/TS TEA 21 TONS
DUBLIN 38 20% D/C NUT 3T DUBLIN 25% D/C NUT 2T DUBLIN 25% D/C NUT 2T DUBLIN 10% D/C NUT 1T
LIVERPOOL 24C CURIOS 1T ANTWERP 10% D/C NUT 1T
LIVERPOOL LUC/SUM LOT 53 75 Large B/S Cotton 25 T 171 Med " " 21½ T LUC/A MAST LOT 54 105 Med B/S Cotton 16½ T
LONDON CFL 96 B/s Fibre 14T
LONDON CFL 50 B/s Fibre 7T MCHST 52 B/s Fibre 7T
DUBLIN H 59 + Chests Tea Various Grades mxd. in lighters 432 CH/TS TEA 26 TONS
DUBLIN H 59 Various Grades mxd. in lighters LBO 876 CH/TS TEA LF 112 ½CH/TS TEA + 59 T
DUBLIN H 59 Various Grades mxd. in lighters 659 CH/TS TEA 41 TONS
MANCHESTER CFL 163 B/s Fibre
DUBLIN 40 B/s Fibre 1T DUBLIN 34 B/s Fibre 5T DUBLIN 240 Bits Fibre 3T DUBLIN 240 Bits Fibre 3T
DUBLIN Sawn Timber (LCO) Green L-284-1 954 P/cs LIGHT RED LAUAN 45 T Mks. mxd in lgtr (LCO) Blue 0-282-½ 518 B/dls DARK RED LAUAN Mks mxd in lgt
MANCHESTER 84 B/s Fibre 12T 24 TONS
MANCHESTER CFL 210 B/s Fibre 30T MANCHESTER 54 B/s Fibre 8T MANCHESTER CFL 120 B/s Fibre 17T MCHSTR 86 B/s Fibre 12T LIVERPOOL 250 B/s Broken Rice 24·6T
LONDON 709/732 CML 123 T 25 B/s Coir Net 4T
LIVERPOOL 82 B/s Fibre 12 T LONDON 54 B/s Fibre 1T LIVERPOOL 240 Bits Fibre 3T L'POOL 80 Bits Fibre 8T
DUBLIN (PART) 500 B/s Broken Rice 49·2T DUBLIN (LCO) L-23 L-23A Red 319 P/cs LIGHT RED LAUAN Mks. mxd in Lighter
DUBLIN H 59 Various Grades mixed in lighters LBO Var. Nos. 268 CH/TS LF Var. Nos. 245 CH/TS 555 ½CH/TS 58 TONS
LIVERPOOL 80 Bits Fibre 1T
DUBLIN 953 P/cs LIGHT RED LAUAN Part ILSP DUBLIN (LCO) Green L-284-½ 82 B/dls LIGHT RED LAUAN Mxd. Mks
L'POOL 250 Pines 6¼T L'POOL 250 Pines 17¾T P.O 710 Pines 940 Pines P3 PW 250 Pines 5½T P2 PW 250 Pines 5½T P2 PW 100 Pines 2¼T P2 SM 500 Pines 8½T P3 SM 300 Pines 7½ T P3 250 Pines 6¼T
P3 PW 100 Pines 2½T P2 PW 50 Pines 1T P2 PW 100 Pines 2¼T P2 PW 100 Pines 2¼T P3 200 Pines 5T P3 290 Pines 7½T
P3 250 Pines 6¼T P3 PW 100 Pines 2½T P3 PW 300 Pines 7½T P3 PW 200 Pines 5T P3 PART 8 Pines P3 250 Pines 6¼T P3 PW 250 Pines 6¼T
LIVERPOOL 296 B/ls Sago Flour 25 T 278 B/ls Sago Flour 25 T Part Sago Flour
NOTE:-All Above shown in Plan All Below shown in Elevation L'POOL 639 B'ls Krabak Coff. 3D8 25T R. Across
LIVERPOOL 254 Var. Dots 1817 P/g White Serayah 47 T
LIVERPOOL 364 B/OLS (2912 P/SK) Red Serayah 30½ T
LIVERPOOL ex SANDAKAN 9 LOGS 8 LOGS (17) LOGS ex SANDAKAN 55 T
LIVERPOOL SINOBRIT in Red ex KOHSICHANG 50 YANG LOGS 200 TONS
LIVERPOOL ex TAWAU S Red Paint 35 SERAYAH LOGS P " " 35 " " FAQ " " 18 " " Total (88) LOGS 211 TONS
LIVERPOOL SEQ 648 192 B/s (1536 Pcs) Red Serayah 12½ T

Fig. 1.

Rapid Turn Round of Ships—continued

Discharging agents as well as loading agents should be requested to co-operate, the former by explaining their difficulties and suggesting possible solutions. The responsibilities of ships' officers should be made clear, too. Even a relieving crew can take an interest in the loading of the vessel, passing pertinent details to the sailing officers when they arrive aboard.

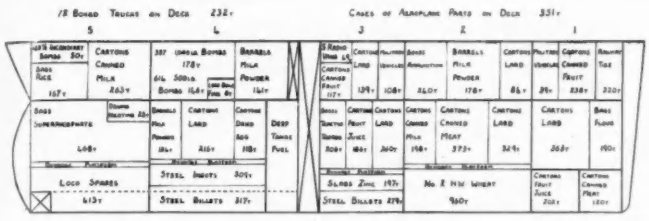


Fig. 2, Stowage plan of Lease-Lend cargo, U.S. to Great Britain during the last war.

It may be that the chief co-ordinator in this matter should be the shipping company's inward freight manager. He is usually the man who has to deal with and account for delays and extra costs at discharge and in many cases he could lighten his burden by obtaining co-operation abroad. The hardest task of all, however, must inevitably be that of the loading agent. As already stated, the attitude of dock workers in many countries has been different since the war and at many ports their co-operation is often difficult to obtain. Even where the loading agent is successful in getting goods tendered to the ship in a satisfactory manner, he will often have much difficulty in getting them stowed how and where he instructs. None-the-less, any improvement in this sphere will pay dividends, sometimes unexpectedly large, and therefore, in this, as in all aspects of this fascinating work, tenacity is a primary need.

Recent Metallurgical Progress

Developments Affecting Harbour Installations

By J. LOMAS

Metallurgy never stands still, and recently there has been a spate of new developments and advances, many of which are directly advantageous to the docks and harbours of the world, and others of potential benefit, demanding exploration in the immediate future. In the following lines the writer has summarized as briefly as possible some of the more important advances in this field.

Suction dredgers are frequently required to handle hundreds of cubic feet of sand, gravel, rock, sludge, etc., per hour; to pump to over 20,000-ft. and dredge to depths of 100-ft. Many of these vessels suffer from excessive wear and require regular and frequent renewal of 16-in. dredger pump liners. The solution of this problem has been found to lie in the application of nickel chromium white cast iron, which is said to have increased the life of these liners by as much as four to five times. The employment of this same alloy for other parts of dredger pumps liable to undergo severe wear is now being considered.

Metal-plastic Coatings

By combining pulverised aluminium with a vinyl resin vehicle, it has been found possible to produce an extra-heavy coating for steel, wood and other surfaces. The coating is applicable by brush or spray to 8 to 10 mil thickness in one application. Six hours suffice to harden it completely, and it can then be filed, buffed or burnished. The coating is claimed to provide effective protection at temperatures between —40 to 300 deg. C., in addition to high resistance to crude oil, petrol, salt water and fresh water.

Powdered steel and a plastic material are being blended into a new product which is said to be as pliable as putty, yet hardens within two hours to a rigid, steel-like mass. The material is a mixture of 80 per cent. steel and 20 per cent. plastic, the plastic being a new, cold-setting resin. The exact functions of this material have not yet been fully investigated, but there is little doubt that in the near future it will be found to fulfil a number of requirements.

New Alloys

A strong, new, weldable, aluminium alloy has been developed as a means of bridging the gap between soft alloys and high strength alloys containing copper. This alloy is readily weldable and in geuneral can be economically applied to parts calling for high strength and resistance to corrosion. It is being applied to booms, ports, rails and superstructures. In composition it is a magnesium silicide alloy included in which is a small copper content. The corrosion resistance is good, and the material can be brazed at somewhat lower temperatures than can other aluminium alloys. Advantages of the alloy are said to be lower cost, lower weight without sacrifice of strength, lower welding cost and better machinability.

New stainless steels include chromium nickel austenitic steels with non-hardenable, non-magnetic properties. One of these is a modified 18-8 steel which work-hardens at a much slower rate than any previous stainless steel, and so enables many parts to be produced from it on mass-production lines at an economical cost. The other is a super-corrosion-resistant steel, economical to work in the hot state and to forge, and designed to give higher resistance to severe chemical attack. This steel is being economically applied to many applications in which other corrosion-resistant materials are costlier to buy or weld, instal and maintain.

New forms and shapes of copper alloys are being produced by extrusion to facilitate production. Such parts possess high productivity, accurate dimensions, and greater strength than the castings previously employed. Architectural bronze made by hollow extrusion is a material offering easy extrusion, good machinability, rigidity and hardness. Bronze alloys are being used for housing bearings, having excellent bearing properties, while they can be cold-swaged and readily machined to a high surface finish. Another new copper material is a hardenable alloy of specially hard temper, containing tellurium.

Pump rods have had their service life increased considerably by metallization with stainless steel. The rods are used under extremely severe conditions of grit, sand, dirt and other foreign matter. Cold-drawn steel was originally used, and later hardened steel rod, but neither material gave a service life longer than 48 hours. Eventually sprayed stainless steel was applied, and increased the life to four weeks, working a 24-hour day. The shafts could be re-metallized three times before being discarded.

The types of stainless steel introduced since 1914 have increased from two to 47, so that the dock engineer has a much broader field to explore. Machining is now possible up to 750 surface feet per min. even with the difficult types. The new manganese-containing stainless steels are supplementing the standard 18-8 chromium nickel types wherever nickel is in short supply. A wrought austenitic high carbon manganese nickel nitrogen quality with a hardness of Brinell 145 is being used. Extra-low-carbon austenitic stainless steels are also proving successful in specific applications. There are also precipitation hardening qualities combining hardness with resistance to corrosion.

A new type of industrial fastener is being made of stainless steel. It is a logical development in the screw-fastening of sheets, being a multi-purpose screw with an undercut, one-piece metal head and a conical washer. Leaks are prevented, shock and vibration absorbed, corrosion resisted and a good, reliable fastener provided. The cost is less than that of comparable screws, and sealing is better and more permanent. The steel used is an 18/12 chromium nickel stainless steel with 0.08 per cent. carbon.

A recent development has been the production of heat-treatable and case-carburized steels with a carbon content up to 0.6 per cent. and a total alloy content up to 5 per cent. Owing to the current shortages of nickel and molybdenum, development in Europe has been in the direction of replacing part of the nickel by chromium. The new alloy constructional steels are finding great favour on the Continent.

Recent Metallurgical Progress—continued

Titanium is becoming increasingly attractive industrially. Light in weight, tough, with high strength and excellent resistance to corrosion, it is said to be stronger than iron in the pure state and to compare with heat-treated alloy steels. It can be welded, and gives a remarkable tough weld. It is stronger in the pure form than most metals and is replacing stainless steel and aluminium in many applications, such as fire walls and structural sections. A better surface finish can be produced on titanium than on steel when it is machined, and power consumption is less, though tool life is shorter.

Structural parts have lately been made of a steel heat-treated to give a tensile strength of nearly 90 tons per sq. in. This steel gives great advantages of strength in ratio to weight as compared to aluminium alloys, and results in a great saving of weight. When a steel containing 0.4 to 0.45 per cent. carbon is heat-treated to a strength of this type, it must be tempered within a suitable range of temperature to prevent it from becoming brittle. In using these steels so treated, however, enough material must be removed by machining to eliminate soft skin and superficial defects, or else failure from fatigue may result.

A new steel has been developed by a British firm. This possesses high resistance to fatigue, great ductility, and good tensile strength. It welds satisfactorily without special precautions, has excellent strength at elevated temperatures, and is easily machined. It contains small additions of boron and molybdenum. The boron content (0.001 to 0.002 per cent.) makes the steel more hardenable and enables it to be used in place of steels of higher alloy content, in many instances. The boron steel has 40 tons per sq. in. ultimate strength and 30 tons per sq. in. yield point. It is as weldable as a mild steel.

Another interesting new material containing a small boron content is a martensitic white iron, which also contains 3.5 per cent. nickel. This has proved useful for protecting pump cylinder liners. By special techniques the metal is integrally bonded to a tough steel supporting shell. It has high resistance to corrosion and abrasion, and is ideal for pump liners of certain types, and also for wash pipes.

Stainless Fencing

In fencing, especially in industrial areas and near docks and harbour installations, maintenance is the costly item. It is now possible to obtain stainless steel chain link fencing. Thus, 13-gauge stainless steel is rapidly replacing 9-gauge galvanised carbon steel. The higher first cost of the stainless steel is offset over a period of time by lower repair, upkeep and renewal costs.

Metal to metal, metal to glass, and metal to porcelain bonding is now being carried out without an open flame or even an arc, with a newly-developed organic welding material. This can be had as rod, powder or paste, is applicable with moderate heat and requires little or no pressure. Standard lap shear specimens have withstood 1.8 tons per sq. in. during tensile tests. Aluminium, glass, wood, cast iron, copper, steel, stainless steel, plastics, paper, plaster and walboard can all be successfully welded with this new material.

Metallized Protective Clothing

For fire rescue and crash entry operations, flame-resistant fabrics are being used in the form of complete suits including leggings, gloves, boots and hood with heat and flame resistant lenses. The fabrics have been fused with metallic layers and topped with aluminium foil. They are completely safe, giving freedom of action and mobility. They protect against flame and heat up to 1,370 deg. C. A suit so made weighs just ten lb. and it is claimed that the temperature inside the suit never rises above that of the normal body.

For welding and hard-facing manganese steel, such as that used in dredger parts, a new electrode has been developed which contains about 33 per cent. of alloys and 0.35 per cent. carbon. Welds made with this electrode are claimed to give four times the abrasion resistance of manganese steels.

Powder Flame Cutting

In dismantling old harbour installations, dock machinery, etc., highly alloyed steels, cast iron, non-ferrous metals, reinforced concrete, etc., prove difficult to cut. This work is now being greatly facilitated by flame cutting with iron powder. This consists of feeding finely-divided metallic particles into the cutting zone of an oxy-acetylene torch. Stainless steel over 9-in. thick, reinforced concrete up to 18-in. thick, aluminium up to 10-in. thick and nickel up to 6-in. thick, can all be successfully cut with the new metallic powder cutting equipment. Powder cutting may be easily added to standard oxy-acetylene cutting equipment. Adapters are available for both hand blowpipes and blowpipes mounted on cutting machines. The metallic powder is carried through its own hose system direct to the point of ignition at the tip of the torch. Addition of the iron powder to the flame causes a strong reaction with oxygen and the temperature is greatly increased, so that the oxygen drives through the base material both chemically and physically.

Roofing Materials

Aluminium corrugated roll roofing and siding is the latest aluminium product for constructional work. It unfolds flat in the same way as ordinary composition roofing; there are no side laps to fit and secure, so that the wind cannot loosen sheets, and there is a ten per cent. economy of material; the roofing can be installed directly on the roof board and needs only a nailing board for end laps. No sheathing or decking is required. End laps need be only 4 to 6-in. The material is rust-proof, rat-proof and fire-proof. Drainage is unobstructed and there is no risk of leakage. Rolls are compact and can be stored in small space. There is no waste, as convenient lengths can be readily cut.

A new all-magnesium four-wheel platform truck rated to handle loads up to 1,000 lb. is believed to be the first magnesium unit of its kind to be mass-produced. It is of American manufacture, and is said to weigh about one-third of comparable steel equipment.

The roof and gutters of a new storage building for the district marine agency of the Department of Transport in Quebec City have been made of high nickel-copper alloy, known as Monel metal. This roof is exposed to a corrosive atmosphere as well as the strain and stress imposed by snow, ice and extreme temperature change. The alloy chosen has a low rate of expansion, a high degree of rigidity and strength, hardness and fatigue strength.

Heavy lifting chains are being made from high strength, heat-treatable nickel alloy steel, which has the requisite strength, toughness and ductility. Typical properties of this material after heat-treatment are tensile strength 56 tons per sq. in., elongation 15 per cent. minimum on 10-in., hardness, Rockwell C, 25 to 29.

New Californian Grain Terminal

A new bulk grain terminal at the port of Stockton, California, is nearing completion, and the owners, Stockton Elevators, state that it is now available for the processing and shipments of all grains. They have published a brochure giving details of the facilities, charges, etc., for use of the terminal, which is within the port limits of San Francisco, thus making no additional time or expense necessary for the clearing of ships at Stockton.

The dock at the terminal is 560-ft. long, with a depth of 34-ft. at mean low water. Two ship-loading spouts on the dock are fed from the head house by belts capable of delivering grain at 800 tons per hour. The loading spouts are so rigged as to permit the simultaneous loading of two hatches of any ship. When working a Liberty-type ship all hatches can be worked without moving the vessel. Receiving facilities at the terminal include three modern truck pits with hoists, an automatic wagon dump for railway wagons, and a receiving belt on the dock for handling grain from barges or ships.

The terminal has storage capacity for 3,000,000 bushels, in 114 bins, which have individual capacities from 75 tons to 1,600 tons, thus permitting the handling of shipments of all sizes. To prevent contamination all the bins are steel-hoppered and the equipment is designed to be self-cleaning.

Submarine Telephone Cable Loading

Factory to Ship Facilities at Erith

For the manufacture of the first Atlantic and other submarine telephone cables. Submarine Cables Ltd., have erected and equipped a new factory at Erith, Kent. The cable on completion of manufacture is conveyed along a gantry to a tank house installation, where it is stored in large steel tanks, pending the arrival of cable-laying vessels.

Large scale preparations have had to be made for conveying cable to H.M.T.S. "Monarch," Submarine Cables' own vessel C.S. "Ocean Layer" or other vessels.

The works which have to comply with various requirements of the Port of London Authority for navigation to adjoining wharves, are shown in the accompanying illustration. There are three spans—that adjoining the tank house being permanent; the other two are demountable. The latter spans are supported by two steel towers, which in turn rest on piled dolphin foundations.

The permanent span comprises a steel bridge approximately 175-ft. long and of tapering width to accommodate the paths of travel of the cable from the two lines of tanks in the tank house. It is of rivetted and welded construction, and has rocker bearings at one end to accommodate inherent flexibility due to expansion. At the top of the first loading tower on the "wharf" a bank of vertical sheaves 7-ft. diameter, and mounted on a horizontal axis, assist in hauling the cable from the tank house to the ship. Small sheaves erected at 6-ft. centres support the cable above the bridge floor.

Between the wharf tower and the river tower, the cable is supported by wire rope spans. From the second or river tower, to the ship the cable is also supported by wire rope spans. The wire ropes will be anchored to the ship by a special device incorporating a nylon rope, the elasticity of which will safeguard against any dynamic pull being applied to the river tower through changes in tidal conditions or rocking of the ship from passing traffic.

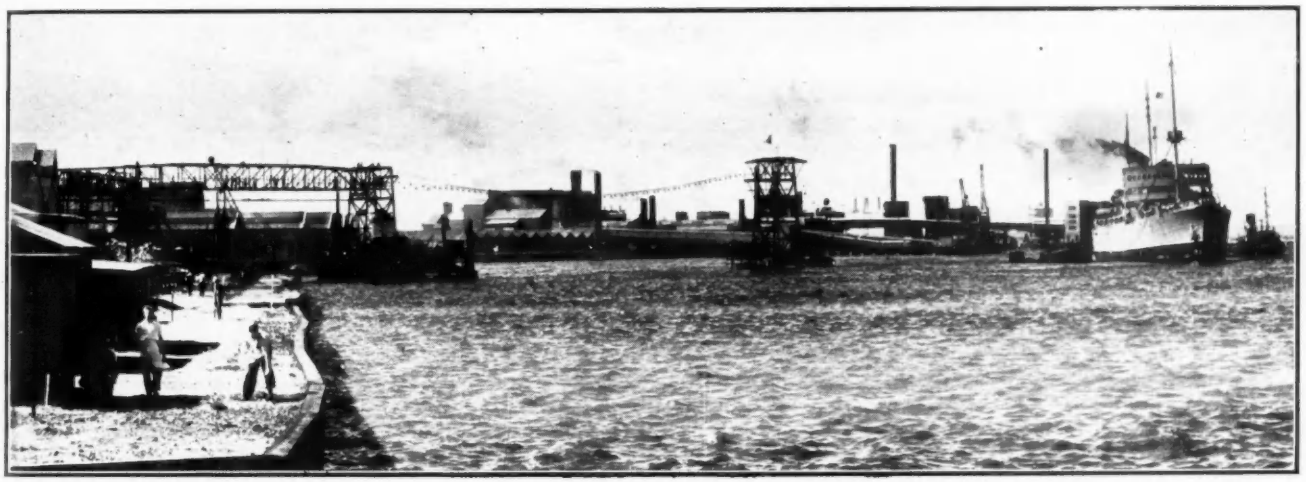
In addition to the hauling device on the wharf tower, there is equipment on the ship to haul the submarine cable along the wire rope spans from which it is suspended at 6-ft. centres on sheaves.

The droop of the catenary formed by the wire ropes requires careful regulation to ensure firstly that the submarine cable does not come in contact with the river water prior to loading on the ship and secondly that the tension in the wire ropes (and consequently the forces imposed on the towers and foundations) are kept within safe limits, and thirdly that the radius of bending of the cable repeater units does not fall below a specified minimum. The wire ropes can be checked by calibration of the nylon ropes; the comparative straightness of the repeater units will be maintained by the rigging of secondary wire ropes slung from the main spans as required by Submarine Cables, Ltd.

In addition to catering for normal dead and superimposed loads and wind forces, the towers, 50-ft. and 60-ft. high respectively, are designed to resist all possible combinations to tensions from the wire rope spans, and to this end they are anchored to the foundations by sixteen 2-in. diameter holding-down bolts. The design of the river tower was complicated by the fact that the wire ropes may be required to take any line within an angle of 25° to either side of the axis of the gantry. This is to allow for alternative points of entry of the cable into the ships, for different mooring positions of the ships to the dolphins and for three lines of cable to be passed simultaneously.

The accommodation of a vessel the size of "Monarch" inshore of the Erith public mooring tiers also presented some problems. To overcome these a considerable amount of dredging was carried out to provide some 28-ft. of water at M.L.W.S. The berth itself consists of three "flexible," energy-absorbing breasting dolphins constructed with high tensile steel H-piles driven to deep penetrations, with separate main screw moorings. Other civil engineering works comprised the construction of the dolphin-type foundations for the cable towers—heavy reinforced concrete decks on steel piles being adopted—and a causeway for small boats.

Sir William Halcrow and Partners, M.M.I.C.E., were consultants to Submarine Cables Ltd. for the dredging and all the river works, including the cable tower foundations. The contractors were The Tilbury Contracting and Dredging Co. Ltd. and John Mowlem & Co. Ltd. The cable towers and bridge steelwork were fabricated and erected by Messrs. Sheppard & Sons Ltd., to the designs of their consultant, C. E. Saunders, Esq., M.I.Struct.E., A.M.I.W., all under the direction of the late Arthur Russell, then architect to Submarine Cables Ltd. Mr. Russell was also responsible for very extensive building and constructional works to re-build and equip the entire cable factory. Messrs. Galbraith Bros. were the contractors.



Permanent span and wharf tower on left; wire rope spans from wharf tower to river tower in centre. Cable ship at dolphins on right.

Savannah Docks Expansion.

The Georgia State Ports Authority has given approval to a £1,610,000 scheme for expansion of dock facilities and warehouse space in the port of Savannah. This decision follows a report by a New York firm of dock experts, Frederick R. Harris and Company, which showed that the planned expansion could be carried out, and that it was also highly desirable because of recent increase in trade for Savannah and the potentially great further increases in tonnage.

Along with this important scheme, the port's authority has also approved several schemes for private development of dockside sites. One is for a grain elevator, to cost nearly £1,000,000.

An instance of the port's sudden rush towards greater activity is the fact that as much shipping was handled during the first six months of this year as through the whole of last year.

New Gantry Cranes at Long Beach

The largest floating self-propelled crane in the world, the YD-171, generally known as the "German crane" has just delivered three gantry cranes to Pier D, Port of Long Beach, where they will be used for loading and unloading bulk cargoes. The gantry cranes, which in themselves are giants, were nonetheless dwarfed by the huge skyscraper German crane on their ride into the Harbour.

The railroad gantries, property of the U.S. Navy Bureau of Ships, have been leased by the Harbour Commission. They are now located at berths 30 and 31, adjacent to the mechanical bulkloader already working on Pier D.

The gantries, using electric magnets, will load scrap iron from rail cars or stock piles, aboard ships at the rate of 60 tons per hour. The magnets, 80-in. in diameter, weighing 13,000 lbs. each, can lift two tons. Using all three gantries, a ship can now be loaded in 7 days, instead of the customary 16 days. Changing over to clam shell buckets, the cranes can handle other bulk commodities such as non-magnetic ores, coal, coke, gypsum, salt, etc.

Two of the gantry cranes weigh 149 tons each and have a maximum lift capacity of 35 tons each. The other crane weighs 210 tons and has a lift of 50 tons. The cranes, operating on 750-ft. of rail track, will utilise a 440 volt, three-phase, 60 cycle power supply, which will also operate a motor-generator set to deliver low voltage power for operation of electro magnets. The cranes have a 24-ft. gauge, the operating cab is 45-ft. from the pier and the radius of the boom is 104-ft.

According to General Manager E. J. Amar, the Port of Long Beach expects to increase its bulk tonnage by more than 300,000 tons during the next twelve months.

The big "German crane" that transported the gantries from a shipyard in Wilmington has a unique history.

It is one of four similar giants used at Kiel, Germany, during World War II. France received one as a war prize but lost it in bombings before a successful departure could be negotiated. Russia also received one which suffered the same fate. England attempted to tow theirs home, but it capsized in the Channel and was lost. That makes the one at Long Beach Navy Shipyard the only one in existence. The local YD-171 was partially dismantled and towed through the Panama Canal to the Long Beach Navy Shipyard, where it is permanently based.

The big crane, with a lift capacity of 425 tons, loaded the gantries, one each day, aboard its own platform and by its own power made the 9 mile trip in two hours to Pier D. A crew of 18 men handled the entire operation.

The Stabilisation of a Tidal Lagoon

Improvements to a Portuguese Harbour

An interesting account has been published* which deals with the varying fortunes of a tidal lagoon on a sandy coast, and with the measures taken from time to time to stabilise the entrance and to maintain a channel for shipping. It is seldom that the changes in the position of an entrance and in conditions generally have been known, as in this instance, since the 10th Century, and on a scientific level for the past 150 years.

The lagoon of Aveiro is a large body of water 32 miles long and 1.8 miles wide, in the central west coast of Portugal, separated from the ocean by a sandy barrier beach, 600 to 8,400-ft. in width. The River Vouga which drains into the lagoon carries a flood flow of 40,000 cusecs and no water in the dry season. The wetted surface of the lagoon is about 17,500 acres, and the tidal flow through the inlet reaches 3,500,000,000 cu. ft. at spring tides.

The author traces the ups and downs of the port of Aveiro, together with the shifting of the entrance and associated sandbanks, during the centuries when control was only partial or non-existent. In 1949 a scheme, which is not yet complete, was embarked upon for the construction of breakwaters in order to canalise the entrance and to direct the tidal flow within the lagoon. A series of hydrographic survey in recent years shows that the present works are fulfilling their object, both as regards the creation of a new regime within the lagoon, and in maintaining a navigable depth over the outer bar.

The author in his conclusion to this well illustrated report points out that the improvement of an inlet on a sandy coast cannot depend either on the upstream current or on the propagation of the tidal wave which are essential factors in the improvement of estuaries. Improvement must essentially depend on an increase in the ratio of tidal volume through the inlet to the volume of sand carried by the littoral drift. He concludes also that it is advisable to fix the inlet as close as possible to the centre of masses of water in the lagoon, and also to canalise the inlet channel across the barrier beach while harmonising the currents from the different lagoon bodies, guiding them to the inlet channel in the best way to avoid the occurrence of eddies and consequent loss of energy. The importance of securing complete transposition of littoral drift across the entrance is stressed, otherwise erosion will occur "downcoast" and with it the danger of a fresh breakthrough which would put the existing entrance out of action.

*"The History of a Tidal Lagoon Inlet and its Improvement. (The Case of Aveiro, Portugal.)" by Carlos Krus Abecasis, Department of Hydraulics, Ministry of Public Works, Lisbon. Reprinted from the Proceedings of the Fifth Conference on Coastal Engineering.

Obituary

The death has occurred in Australia of **Mr. Frederic Andres,** who was Engineer for Development of the South Australian Harbours Board. He was 56 years of age.

Mr. Andres served the Board for 34 years. He had been Designing Engineer for twenty years before his appointment as Engineer for Development. He took a leading part in the long term planning of the Port of Adelaide, and prepared plans for the establishment and development of harbour installations throughout the State of South Australia. He was responsible for the designing and construction of Ocean Steamers' Wharf, Port Adelaide, which has become the prototype for all modern deep-draft concrete wharves at that port.

Mr. Andres was a corporate Member of the Institute of Engineers of Australia and a Fellow of the Australian Planning Institute.

Correspondence

To the Editor of "The Dock and Harbour Authority."

Dear Sir,

Pneumatic and Other Breakwaters.

I have read with great interest the Report by J. T. Evans on investigations into the operation of pneumatic breakwaters, which was published recently in the Proceedings of the Royal Society, Volume 231, and which appears in this month's issue of your Journal in an extended form. There is a further reason for my interest in that the model used in the investigations was constructed as a 1/12th scale replica of the installation at Dover, the layout and design of which was the responsibility of my Company.

The author of this paper does less than justice in describing the results achieved at Dover. It is true that oscillations were set up between the dock gate and the airline which produced spurious readings on the wave recorder. There were, however, other methods of measuring the wave reduction secured, and the method adopted was that of visual observation of the height of wave crest above trough which were measured against the berthing jetty before and after passing the pneumatic breakwater. The averaged results of a number of observations showed that waves initially 5-ft. high were reduced to 15-in., while waves 4-ft. high were reduced to 9-in. Further, it should be said that the basis of my Company's work at Dover was an undertaking to reduce 5-ft. waves to 2-ft. or less and that our commitment was fulfilled.

In view of the above, it is surprising to find that the author applies the results of model and theoretical work to the conclusion that the currents generated by the prototype would reduce the wave energy at Dover by 10 or 12 per cent. (which means a **height** reduction of about 3.3 per cent.). Such a reduction is not in accordance with the facts, is imperceptible to the eye and would not have enabled the Train Ferry to sail on five or six stormy occasions.

There was published in the June, 1955, issue of your Journal an account of the recent German model experiments on the same subject, together with a review of that work by me. It is to be regretted that the author of the present article neither includes these articles in his bibliography nor takes issue with the interpretation of results which were put forward both by the German writer and by myself. Whereas the Germans conclude that the pneumatic breakwater is the most economical solution in all cases where fixed installations must be ruled out, Mr. Evans concludes from models and theory that the complete calming of waves 200-ft. or more in length is unlikely to be economic and may be impracticable.

While there are serious unresolved discrepancies in the results to date of researches into this problem, it is pleasing to note that Mr. Evans has driven the last nail into the coffin of the idea that a pneumatic or any other system which generates horizontal currents in opposition to wave motion can be made to work economically. In this he confirms what has already been concluded both through models and by theory by a number of authorities to whom he has referred in his paper. He has not, however, discovered, in my view, how the successes of the El Segundo breakwater, working on an applied air power of approximately 1 h.p. per yard, and of the Dover breakwater were brought about.

Since the model fails to reproduce the results obtained with the prototype, it is evident that some other mechanism is at work besides that of opposing currents. I have referred to the probable nature of this in my appreciation of the German Paper referred to above, in which the principal effect of a pneumatic breakwater is considered to be that of creating a boundary or discontinuity beyond which the waves fail to penetrate.

This boundary effect is caused by the existence of gross eddies resulting from the rising stream of bubbles and it is natural to question whether this mechanism can be reproduced at all in a tank experiment with any expectation of dynamical similarity. It will be obvious that in a system where viscosity and friction play a part (as distinct from the exclusively gravitational systems of Taylor and Evans), it is not possible to secure dynamical similarity unless the Reynolds number is the same for both model and prototype. In short, it may be said that in order to secure similarity in respect of both the gravity (Froude) ratios of tank and model, and also of kinematic viscosity (Reynolds) relations, it would be necessary for the model tank to be filled with a fluid whose kinematic viscosity was 1/41.5 that of the sea water prototype. There is no liquid anywhere near fluid enough to satisfy this requirement.

It seems therefore that the true mechanism of the pneumatic breakwater may be inherently impossible to demonstrate in a model, at any rate without a gross distortion of one or more components of the scale relationship.

Yours faithfully,

A. H. LAURIE,
Pneumatic Breakwaters Ltd.

To the Editor of "The Dock and Harbour Authority"

Dear Sir,

Two-Storey Transit Sheds.

The very informed and comprehensive article on Two-Storey Transit Sheds by Oberbaurat Dipl. Ing. H. Jung in the November issue of your Journal is most welcome and particularly interesting to those who have had the fortune to see Herr Jung's researches put into practice in the post-war reconstruction of the Port of Bremen. I would like, however, to draw attention to an error in the Technical Data for Two-Storey Transit Sheds, Fig. 2, on page 208 and to two other errors. The permissible live load for the upper floor of the West India Docks shed, Item 12, should be 1,500 kg./m², not 500 as given. This error is repeated at the bottom of page 207. On the diagram of the shed on page 209, only one rail track is shown on the road side instead of two. The location of the sheds on page 208 should read "import south side," not "north side."

Apart from these minor errors Herr Ing. Jung's summary of the relevant planning considerations and operational practices are of considerable value in establishing a basis for future thinking on a matter which has long been the subject of controversy.

There can be little doubt that where adequate space exists to provide the covered area needed for transit operations, and also for the circulation of road and rail traffic, a single-storey transit shed is the most economical and efficient installation. As examples of this may be quoted the new cargo transit sheds at Port Newark, New Jersey ("Modern Cargo Marine Terminals," Dock and Harbour Authority, March, 1955), and No. 1 Berth, Tilbury Dock, Port of London Authority, which is at present under construction.

However, where the area available for the shed is restricted, a two-storey structure is, as Herr Ing. Jung concludes, a justifiable solution.

In London, where space for dock development is often restricted because of the heavily built up nature of the dock environs, multi-storey quayside sheds have been provided over many decades. Generally in such sheds the ground floor is used for transit purposes and the upper floors for storage, as, for example, in the range of four-storey sheds in the Royal Victoria Dock completed in 1939.

Of the sheds constructed since the war, the West India Dock sheds were provided with three storeys, the uppermost storey in this case serving to augment the warehousing capacity which had been depleted by war damage. The decision to build a two-storey transit shed at Shadwell Basin, London Dock, was dictated by a site severely restricted in width, and here the upper storey is cantilevered out over the rear road ("Dock and Harbour Authority," September and October, 1952).

An interesting example of two-storey construction is No. 8 Shed in the Swedish Yard, Surrey Commercial Docks, where what has proved to be a remarkably efficient lay-out was made possible by the fortuitous juxtaposition of a deep water berth and a barge berth separated by a peninsular site some 250-ft. wide. The two-storey shed in this instance provides for discharge and delivery from and to ship, barges and road transport.

The need to keep the areas surrounding sheds built on restricted sites unobstructed by small buildings so as to provide a free flow of vehicular traffic must constantly be borne in mind and is met on this site by providing such accommodation as lavatories and Customs lock-ups within the shed.

Port of London Authority,
Trinity Square, E.C.3.
28th November, 1955.

Yours faithfully,

G. A. WILSON,
Chief Engineer.

Book Reviews

"Foundation Engineering" by Rolt Hammond, A.C.G.I., A.M.I.C.E. Published by Odhams Press Ltd., price 21s., 191 pages.

This publication, which is essentially a survey of foundation problems met with in practice, is written for the benefit of both the young and also the experienced Civil Engineer. While the treatment of these problems is mainly descriptive, the solutions discussed emphasise the value of experience not only in the design of foundations but also in the planning and carrying out of their construction.

The first two chapters, those on "Soil Mechanics" and "Site Exploration" respectively, form an introduction to the different problems discussed later. Of necessity these subjects have been dealt with briefly. Much of Chapter 2 is devoted to geophysical methods of exploration and the author has described several instances of the successful use of these methods. It would have been of value to engineers if he had quoted some instances of their unsuccessful use. It cannot be over-emphasised that it is necessary to have a true perspective of the limited value of geophysical methods as a means of obtaining reliable data for foundation designs.

Chapter 3 on "Piled Foundations" is well arranged and contains information that should be of value to young engineers. Chapter 4 on "Vibration—Controlled Foundations" contains much information not previously available in book form. Many failures to machine foundations can be traced to vibration difficulties, and the numerous problems discussed by the writer, and the solutions used, will form a valuable guide to engineers concerned with the reduction of vibrations transmitted into the foundation.

In the remaining chapters on "Foundations for Houses, Buildings, Bridges and Maritime Structures" the writer has quoted many interesting examples of the methods adopted by various engineers in overcoming their particular problems.

"The Law of Sea and Air Traffic," by Derek H. Hene, M.A. (Cantab) Barrister-at-Law, of the Inner Temple and the South Eastern Circuit. Published by Messrs. Shaw & Sons, Ltd., Fetter Lane, London, E.C.4, price 50s.

Here, conveniently consolidated into one book, is a concise summary of traffic laws, both for sea and air. It is thoroughly up to date in that account has been taken, in the compilation of the 1954 International Collision Regulations.

Part 1 concerns Sea Traffic Law. A full account is given of the International Collision Regulations. This is followed by a chapter on British Local Rules. In view of the fact that under Article 1 (a) and 30 of the International Regulations, the International Rules apply unless they are incompatible with local regulations, only those parts of local regulations are given which are of essential importance to major shipping traffic or which are materially different from any International Rule relating to the matter concerned.

The same considerations apply to the selection of Foreign Local Regulations. Included in this section are Local Regulations of the British Dominions, the British Commonwealth, the United States of America and fifteen other major maritime countries.

Copious references to case law are given in footnotes; these will be useful to students, while they do not interfere with the concise text.

Chapter 4 concerns Safety regulations, which are summarised those regulations which in the author's view are of major interest or importance being quoted in full. This chapter is in two parts, the International Safety Regulations, and British Safety Regulations.

The second part of the book deals with Air Traffic Law, and its growth from the Chicago Convention of 1948. International Regulations are given in full, followed by English Air Traffic Law Summary. A section follows which deals fairly fully with such case law as has accumulated.

Foreign Air Regulations are summarised, inasmuch as they diverge from the main provisions laid down, under the Convention by the International Civil Aviation Organisation.

Part Three deals with Radar Control, Limitation of Liability, both shipping and aviation, and the book concludes with a chapter on "English Legal Procedure in Case of Accidents.

This book should be of use to port authorities, and to all concerned with the movement of ships and aircraft. It would also provide a useful "refresher" course in convenient form for candidates for Extra Master.

"Dangerous Goods and Others," by Dr. Jules Aeby, fourth edition, published by Editions Anversois, Antwerp, price £ 10s. (Belgian Francs 770).

This book was previously published in 1938, and supplements were added in 1950, and in 1952. Now all the information contained in three publications has been consolidated into one compact volume. It has been revised and its scope has been increased by the addition of details of goods which, while not necessarily dangerous, require documentation in maritime quarters.

The number of chemical substances whose properties and proper method of stowage are described reaches eight hundred and seventy-one.

The entire book is trilingual, being written in English, French and German. Its sphere of usefulness is thus greatly increased. While the main intention is to provide information which will serve as a guide to stowage of dangerous goods on board ship, it will no doubt be equally valuable as a work of reference in the hands of port authorities and warehousemen. A complete index in three languages is also provided.

"Hamburg Dockers" ("die Hamburger Hafenarbeiter") by Dr. Werner Klugmann published by "Hansa," Messrs. C. Schroedter and Coy., Hamburg. 130 p.p., price 9 D.M.

This new volume dealing with the social problems of those connected with the commercial handling of goods in the Port of Hamburg is the second of a series sponsored by the department of the Science of Commerce of the University of Hamburg. Dr. Klugmann studies the Hamburg dockers' life and means of livelihood paying particular attention to the many developments and changes during the period following the recent war. The varied social problems are examined with sympathetic understanding. His analysis should be of considerable value to the publications section of the International Labour Office (Geneva), and to all those connected with port working.

The treatise is presented under three main headings, Work; Wages; and Living Conditions. Dr. Klugmann examines the reduced fluidity of labour, the relationship of employer and employee, the great improvement in the strength of organised labour, accident cover, sick and unemployed benefits, pensions, regulation of hours of labour, transport to place of work and social arrangements.

The wage question is examined very fairly under two headings: the nominal wage, and the real wage. There is also considered the application of the personal or specialist wage, recompense for services rendered, and the problem of the formation of a labour reserve.

The Professor emphasizes the value of personal contact between dockworker and employer stressing the importance of educational and social gatherings and the need for improved living conditions.

In the interests of labour peace and well-being, it is imperative to initiate schemes to widen the knowledge of the workers and to bring home to them the need for co-operation. The dockers' service to the community is important and his job should be attractive and secure, not as a right but as the fruit of his labour. The stimulus of goodwill and understanding may yet weld the present diverse interests into a working whole.

British Standard for Fibre Cores for Wire Ropes. (B.S.525:1955.)

This British Standard was first published in December, 1933, and has recently been revised in the light of the technical information available under present conditions.

The standard covers a range of fibre cores of manila (Abaca), phormium tenax, sisal, hemp and jute, suitable for wire ropes $\frac{1}{8}$-in. —4-in. circumference for cranes, lifts and hoists, shipping, oil-wells and collieries.

The standard is available from the British Standards Institution, Sales Branch, 2, Park Street, W.1, and also from B.S.I. Manchester Office, Coronation House, Market Street, Manchester. Price 3s.

Manufacturers' Announcements

Shipborne Diesel Electric Cranes

The Canadian Motor Vessel "Lachinedoc" of 4,000 tons deadweight, which is being built at Newport, Mon., by the Atlantic Shipbuilding Co. Ltd., is the first ship to be equipped with British diesel electric cranes, manufactured by Steel Engineering Products Ltd., of Sunderland.

The "Lachinedoc," which is herself unusual in being the first ship larger than a tug to be built to the "Hydroconic" hull design, is intended for the carriage of bulk cargoes on the Great Lakes River and Gulf of St. Lawrence. Since however her cargoes will not be exclusively bulk goods, she has been equipped with Coles Cranes in order to facilitate loading and discharge at ports where cranage is lacking.

Two Coles F 1210 standard cranes are provided, and mounted in positions which enable them to plumb the entire area of two large holds. The F 1210 Crane normally appears as a mobile crane, mounted on rubbers, but in this instance it has been modified by being mounted on a special carriage, manufactured by the Atlantic Shipbuilding Company. The carriage runs on a greased skidway on a raised portion of the deck between the hatches, so that the crane may be winched to one side or the other according to the position of the ship in relation to the quay. The cranes are normally stowed amidships; when secured for loading or during a voyage the carriages are bolted to the skidway. A winch is provided for shifting the crane to each of its three positions. This arrangement has been adopted in preference to the possible alternatives which are either to provide a larger crane with a fixed base on the centre line of the ship, or two smaller capacity cranes in fixed positions at both port and starboard sides.

The operator is well placed as regards range of vision, and the whole of the quay area within the crane's range is visible to him. Hoisting speeds of 2½-ft. per second can be obtained with a single fall of rope, the lifting range extending from 3,000 lbs. at 40-ft. radius to 6,000 lbs. at 27-ft. The maximum lift, using double fall of rope is 12,000 lbs. at 15-ft. radius.

The Coles diesel-electric system of transmission provides a fully controlled smooth flow of power at the touch of a lever. The variable voltage generator coupled to the diesel engine provides power for three separate motors, for hoisting, slewing and derricking motions respectively. Considerable economies are claimed for this system, in that the driving system of all motions is not kept constantly running; the prime mover is merely speeded up when necessary to produce power according to the need. The prime mover is a standard Perkins P.4 diesel engine.

As stated above, the cranes mounted on the "Lachinedoc" are standard production models, with the exception of the skid mounting. The only other modifications are superficial, and have been introduced for the sake of protecting the machinery from weather and from swinging loads. Extra protection has been provided to isolate the controls and brakes from sea spray, a detachable cover has been fitted to the radiator, and the front of the cab is strengthened by the provision of ¼-in. m.s. cladding.

New Fire Prevention System

A new technique of detecting incipient fire before any heat is generated or flame occurs, known as the Minerva Fire Detector, is being manufactured by the Minerva Detector Co. Ltd., of Richmond, Surrey.

The sensitive element in this new system is an ionisation chamber in which the air is rendered conducting by the alpha particles emitted from a small quantity of radium compound having a theorectical life of 1,000 years. The entry of smoke or other products of combustion into the chamber radically changes the electrical characteristics of the ionised air. These changes call into action a balanced circuit, the output of which may be used to raise an alarm, or to set off automatic fire extinguishing equipment. The heart of the balanced circuit is a cold cathode gas-filled tube, inoperative until triggered by the presence of smoke, etc., in the ionisation chamber. No current flows through the valve while the system is on, and therefore there is nothing in the detector to wear out. Once the system has operated it can be immediately reset. The detectors are connected to a combined control unit and signal panel. A display on the panel indicates the location of the alarm, and from it, a remote indication can be transmitted to a distant fire station or watch office.

Each Minerva detector protects about 1,000 sq. ft. of floor area.

New High-Powered Dutch Tug

One of the highest powered tugs yet constructed, the "Edgar Bonnet" was recently completed at L. Smit and Zoon's yard, Kinderdijk, Holland. The tug had been ordered from I.H.C. Holland last year for the Cie Universelle du Canal Maritime de Suez, Paris.

With an overall length of 50.125 metres, the tug is 46.00 metres long b.p. and has a 12.00 metre beam. There is a mean draught of 4.5 metres and the brake h.p. of the motors is 5,500. The towing equipment, which has been specially designed, has been provided with a hydraulic-pneumatic winch capable of absorbing the strain on the cable when operating in very heavy seas and on a short tow. The equipment includes four electrically driven salvage pumps, two with a capacity of 100 tons per hour and two of 60 tons per hour. There is also a 150-ton fire fighting pump. The two engines are of the Smit-M.A.N. type each having eight cylinders,

480 mm. in diameter with a piston stroke of 840 mm. Each drives KAMEWA reversible pitch propellers, whose power in a tropical climate is 2,250 b.h.p., and during trials in Holland was 2,750 b.h.p. The speed at trials running free was 15 knots.

Current is supplied for the various auxiliary machinery and for other purposes throughout the vessel from three 115-kW, 220-volt M.A.N.-engined dynamos and the steering gear is electro-hydraulic. The tug has a bunker capacity of 120 tons of diesel oil and can carry 50 tons fresh water. The fuel is sufficient for five days of twenty-four hours when the tug is proceeding at full speed.

Manufacturers' Announcements—continued

A New Hydraulic Luffing Crane

For many years the electric crane has outdated the hydraulic crane and although it has many and obvious advantages, some of the desirable features of the hydraulic crane have been lost.

The Clyde Hydral-luff is virtually an electric crane but uses hydraulic fluid as a transmission medium for operating the luffing motion, thus restoring to an electric crane all the advantages previously associated with hydraulic luffing.

The fluid is metered by two pumps pumping into one end and out of the other end of a cylinder. The jib is always under control and can only move in relation to the speed of the driving motor. When the jib is at rest, the fluid is locked in the system by means of an automatic valve and a solenoid brake acting on the motor shaft. This provides a double lock to prevent the pumps from being driven in the reverse direction by the inertia of the jib. Thus the jib is held rigidly when not being luffed. A relief valve provides an effective safety measure to protect the crane if the luffing motion is roughly handled.

A salient feature is the elimination of shock when stopping the luffing motion. Also, the hydraulic fluid being oil is not subject to freezing where cranes are working in cold climates.

The Clyde Hydral-luff is manufactured by Clyde Crane & Booth Ltd., Rodley, Leeds, with capacities of 3, 5, 7½ and 10 tons.

New Fork Lift

A new fork lift machine was on show at the 1955 Building Exhibition at Earls Court which, unlike all other existing fork lifts, is detachable from the mobile power unit. When the lift is not required, the Power Unit is available for other duties.

Sturdily constructed, the machine is able to travel without difficulty over rough ground surfaces such as ruts and rubble. It is equally suitable for smooth surface work and will lift a 10 cwt. load up to a height of 10-ft. 9-in. The new fork lift is hydraulically controlled by two levers which operate self-neutralising two-way valves. A flow control valve ensures an even descent of the fork whether a lift or a heavy load is being carried.

Unlike most traditional fork lift trucks, this machine is rear-mounted and provides the operator with clear vision of his work. There are a considerable number of attachments for the Mobile Power Unit apart from the fork lift.

This machine is manufactured by Messrs. Massey-Harris-Ferguson, Coventry.

A Mechanical Handling Film

A new 30-minute 16 mm. documentary film in colour, forming a survey of modern handling methods and appliances as demonstrated at Mechanical Handling Exhibitions, was shown in London recently. The film selects one or more examples of each of the various classes of equipment shown at the exhibitions, including mobile cranes, crate packing and unpacking machines, radio-controlled overhead cranes, fork trucks with various attachments and gravity roller, belt and slat conveyors. The film, "Mechanical Handling on Show," is available free on loan and application should be made to "Mechanical Handling" (an Associated Iliffe Press publication), which organises the exhibition.

Diesel Shunting Locomotives For South Africa

Two 3-ft. 6-in. gauge diesel-mechanical locomotives, built by Messrs. Hudswell, Clarke & Co. Ltd., of Leeds, have recently been purchased by I.S.C.O.R. (South African Iron and Steel and Industrial Corporation) for slag tipping at its Vanderbijl Park steel works.

Each locomotive is powered by a Paxman 12RPHL diesel engine, which is set to develop 412 b.h.p. at a maximum speed of 1,250 r.p.m. under site conditions of 4,900-ft. above sea level, and a maximum ambient temperature of 95 degrees F. Under similar conditions the intermittent (1 hour) rating is 453 b.h.p. The engine starting is by means of a starter motor on the "Bendix" principle.

The locomotives each have a total adhesive weight of 64.3 short tons, and are mounted on eight coupled wheels 3-ft. 9-in. in diameter.

Compressed air brakes are incorporated for braking and vacuum brake equipment, together with the necessary train piping, is also included for the operation of vacuum-braked train stock. Vacuum exhausters and air compressors are belt-driven from the diesel through the auxiliaries traction type fluid coupling.

The water cooling system is at the front end of the locomotive, and a lubricating oil cooling system is incorporated in the radiator. Draught is induced through the cooling elements by a belt driven 48-in. "Axial Flow" fan. All auxiliaries are driven through a Vulcan-Sinclair traction coupling fitted on the "free" end of the engine crankshaft. Included in the transmission is a Vulcan-Sinclair scoop control fluid coupling which performs the duties of a main clutch between the engine and the gearbox. The latter, which is fitted beneath the floor of the open platform at the rear of the cab, is of the S.S.S. Powerflow type, providing three speeds in either direction of travel, with the additional choice of a "low" range gear for heavy shunting, and a "high" range gear for lighter loads. This change speed mechanism is of the synchro-self-shifting type where the gear wheels are in constant mesh, and an S.S.S. clutch is provided for engaging the gear selected.

Each locomotive has an auxiliary 440 volt D.C. generator for supplying the electric current required to operate a 50 h.p. motor-driven auxiliary air compressor (not incorporated on the locomotive). The auxiliary generator is chain-driven from an auxiliary gearbox provided with sliding gears for bringing the driving chains into motion.

Wheel centres are of cast steel with balance weights cast solid, and the tyres are 3-in. thick, 5¼-in. wide and 3-ft. 9-in. diameter on tread. Each locomotive is painted and varnished.

Diesel Powered Haulage Winch

A diesel-powered winch which hauls loads up to 5,000 lbs and has a gearbox giving a choice of four different line speeds, is being manufactured by Messrs. Richard C. Gibbins and Co. Ltd., of Birmingham.

When changing from one gear to another, a disc-type friction clutch disconnects the engine from the gearbox. For free spooling a quick acting coil clutch disconnects the rope barrel from the drive. The engine is a Perkins P4 four-cylinder diesel developing 34 B.H.P. at 1,500 r.p.m.